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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 43

PROCEEDINGS
OF THE
SECOND GOOD ROADS INSTITUTE

HELD AT THE
UNIVERSITY OF NORTH CAROLINA
FEBRUARY 23-27, 1915

Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary

*Held under the Auspices of the Departments of Civil and
Highway Engineering of the University of North
Carolina and the North Carolina Geo-
logical and Economic Survey*



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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., November 1, 1915.

To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.

SIR:—The second Road Institute was held at the University of North Carolina, February 23-27, 1915, under the auspices of the State University and the North Carolina Geological and Economic Survey. This second Institute opened with a good attendance and many subjects of vital importance to the road work of the State were discussed with much benefit to the road engineers, superintendents, county commissioners, etc., in attendance. It is believed that the proceedings of this Institute should be put in permanent form and I am, therefore, submitting its proceedings for publication as Economic Paper No. 43 of the publications of the North Carolina Geological and Economic Survey.

Very respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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PROCEEDINGS
OF
SECOND ROAD INSTITUTE
HELD AT
UNIVERSITY OF NORTH CAROLINA
FEBRUARY 23-27, 1915

INTRODUCTION

A resolution was passed by the first Road Institute, held March 17-19, 1914, requesting that the University of North Carolina and the State Geological and Economic Survey make the Goods Roads Institute a permanent affair, so that the road engineers, superintendents, road commissioners, county commissioners and others interested in road building throughout the State could get together and hear discussions of the various road problems to be met with in North Carolina and thus try to bring about improved methods of road location, administration and construction.

In accordance with this request, the North Carolina Geological and Economic Survey sent out the following letter to the road officials of the State:

January 20, 1915.

MY DEAR SIR:—Because of the success of the Road Institute which was held at the University of North Carolina in March, 1914, it has been decided to make the Institute an annual occurrence, and in 1915 it will be held during the week beginning Tuesday, February 16th. The Institute will last four days and special notices regarding the program will be sent out later.

This Road Institute is considered a clearing house for road problems in North Carolina, and is of very great value to all those connected with road work in this State. I am writing to ask that your board take up the question of detailing your road engineer or superintendent, or both, to the Institute and provide for the payment of their expenses, considering their attendance as part of their official duties. I believe the good which will result from the knowledge gained by the engineer will more than offset any expense. We should also like very much to have one or more members of your board in attendance at the Institute. Last year there were 24 counties represented and all were enthusiastic over the meetings and the continuance of this Institute. I will appreciate it if you will let me know what action you take regarding the above, and sincerely hope that you can act favorably upon detailing your engineer, superintendent, or other road officials to attend the Institute; and also that you will be able to attend yourself.

With best wishes, I am

Cordially yours,

JOSEPH HYDE PRATT,
State Geologist.

In giving notices to the press in regard to the institute, it was stated that while the subjects of "Sand-clay and Topsoil Roads," "Maintenance of Highways," and "Culverts" would be given special consideration, other problems relating to road building, such as road location, worn-out macadam roads, bituminous compounds, contracts and specifications, blasting materials, etc., would come up for discussion.

There was an increased attendance at this Road Institute as compared with the first one. The number of registrations was 80, with 29 counties represented, as follows:

Alamance	Greene	Orange
Anson	Guilford	Rockingham
Alleghany	Halifax	Rowan
Craven	Harnett	Sampson
Cumberland	Henderson	Vance
Davidson	Hoke	Wake
Duplin	Iredell	Warren
Durham	Lee	Wayne
Edgecombe	Mecklenburg	Yancey
Forsyth	New Hanover	

The following are the names of those who registered at this second Road Institute:

LIST OF MEN ATTENDING GOOD ROADS INSTITUTE

Name	Address	Title	County	Company
Arnold, J. H.	25 Rowland St., Richmond, Va.			John Baker, Jr., Road Oil and Ashphalt.
Baity, H. P.	Harmony		Iredell	
Blackmer, W. S., Jr.	Salisbury		Rowan	
Borden, J. C.	Goldsboro	Trustee	Wayne	
Boren, G. S.	Pomona		Guilford	Pomona Terra Cotta Co.
Breeze, V. W.	Durham		Durham	
Brooks, Benj.	Kansas, City, Mo.			International Clay Products Bureau.
Brown, D. Tucker	Chapel Hill	Engineer	Orange	
Brown, R. T.	Chapel Hill	Engineer	Orange	
Burnett, R. A.	Wilmington	Superintendent	New Hanover	
Carr, W. E., Jr.	Durham		Durham	
Cobb, Collier	Chapel Hill		Orange	
Cobb, Collier, Jr.	Chapel Hill		Orange	
Coble, R. P.	Sanford	Engineer	Lee	
Cosby, J. W. H.	Reidsville	Engineer	Rockingham	
Craven, E. F.	Greensboro		Guilford	
Croom, A. E.	Wallace		Duplin	
Crosby, W. W.	Baltimore, Md.	Engineer		
Davidson, J. A.	Greensboro	Superintendent	Guilford	
Drane, B. S.	Charlotte	Engineer	Mecklenburg	

Name	Address	Title	County	Company
Eagle, D. E.	Statesville		Iredell	
English, F. M.	Pittsburgh, Pa.			
Fallis, W. S.	Henderson	Engineer	Vance	
Ferrell, R. M.	Durham	Patrolman	Durham	
Fields, B. L.	Greensboro		Guilford	
Fleming, Wm. R.	Cincinnati, O.			Newport Rolling Metal Culvert Co.
Flowers, G. W.	Durham	Chairman Board County Com- missioners.	Durham	
Fore, C. L.	Charlotte		Mecklenburg	
Galvin, Geo. P.	Wilmington			Carolina Metal Products Co.
Harper, Henry	Charlotte		Mecklenburg	
Hickerson, T. F.	Chapel Hill	Engineer	Orange	
Higdon, R. W.	Fayetteville		Cumberland	Salisbury Metal Culvert Co.
Higgins, C. W.	Greensboro		Guilford	
Hines, C. P.	Hillsboro		Orange	
Hocutt, H.	Gerton	Superintendent	Henderson	
Hogan, H. C.	Chapel Hill		Orange	
Holder, B. B.				
Homewood, R. M.	Burlington		Alamance	
Hughes, Jr. N. C.	Weldon	Engineer	Halifax	
James, Robt. L.	Chapel Hill		Orange	
Johnson, R. N.	Snow Hill	Engineer	Greene	
Kiker, W. B.	Durham		Durham	
Koerner, H. R.	Raleigh		Wake	Carolina Metal Products Co.
Lilly, E. J., Jr.	Fayetteville		Cumberland	
Lilly, H. M.	Raeford		Hoke	
Long, S. L.	Chapel Hill		Orange	
McAllister, J. C.	Wilmington	Superintendent of Streets.	New Hanover	
McGregor, J. D.	Wadesboro	Superintendent	Anson	
Martin, J. W.	Tarboro	Superintendent	Edgecombe	
Miller, C. M.	Salisbury	Engineer	Salisbury	
Mullican, N. S.	Winston-Salem	Engineer	Forsyth	
Mullis, Ira B.	Lumberton	Engineer	Harnett	
Patterson, H.	Burlington		Alamance	
Pennell, J. Roy	Snow Hill	Engineer	Greene	
Peyton, Wythe M.	Burnsville	Engineer	Yancey	
Phipps, J. L.	Greensboro		Guilford	
Plott, J. T.	Greensboro		Guilford	
Pollard, J. M.	Durham	Superintendent	Durham	
Price, T. M.	Madison	Engineer	Rockingham	
Pratt, Joseph Hyde	Chapel Hill		Orange	
Quevedo, Manuel	Greensboro		Guilford	
Richardson, E. G.	Charlotte		Mecklenburg	
Schlitz, M. M.	Charlotte		Mecklenburg	

Scott, Sam D.....	Warrenton.....	Engineer.....	Warren.....	
Shields, E.....	Salisbury.....		Rowan.....	
Slaughter, J. H.....	Newport, Ky.....			
Smith, John E.....	Chapel Hill.....		Orange.....	
Snowden, R. E.....	Snowden.....	Engineer.....	Craven.....	
Spalding, J. J., Jr.....	Baltimore, Md.....			
Spoon, W. L.....	Burlington.....	Engineer.....	Alamance.....	
Squires, J. H.....	Wilmington, Del.....			
Teer, Nello F.....	Durham.....	Contractor.....	Durham.....	
Varner, G. C.....	Greensboro.....			Dixie Culvert Co.
Whitfield, F. M.....	Atlanta, Ga.....			Barber Asphalt Paving Co.
Whitfield, L. E.....	Clinton.....		Sampson.....	
Wicker, W. S.....	Elon College.....		Alamance.....	
Wood, J. W.....	Greensboro.....		Guilford.....	Dixie Culvert and Metal Co.
Wright, R. H., Jr.....	Nashville, Tenn.....		Davidson.....	

SCHEDULE OF LECTURES*

TUESDAY, FEBRUARY 23.

10:00 A. M.-1:30 P. M. Registration in Peabody Hall. Assignment of rooms.

2:30 P. M. Formal opening of the Institute.

Address—President GRAHAM, of the University of North Carolina
Purposes of the Institute—JOSEPH HYDE PRATT, State Geologist
and Director of the Institute.

3:30 P. M. LOCATION, DESIGN, AND CONSTRUCTION OF ROADS.

Short papers as follows:

Considerations Governing the Proper Location of Roads—T. F.
HICKERSON, Associate Professor of Civil Engineering of the
University.

The Effect of Grades Upon the Location and Design of Roads—
D. TUCKER BROWN, Director of the North Carolina Good Roads
Association.

Economical Method of Moving Earth in Road Construction—
N. C. HUGHES, JR., Highway Engineer of Halifax County.

Economical Methods of Moving Rock in Road Construction—
W. S. FALLIS, Highway Engineer of Vance County.

Economical Methods of Handling Surfacing Materials—R. P.
COBLE, Highway Engineer of Lee County.

Discussion.

8:00 P. M. Smoker in Peabody Building.

WEDNESDAY, FEBRUARY 24.

9:00 A. M. SAND-CLAY, TOPSOIL, AND GRAVEL ROADS.

Address by C. M. STRAHAN, Professor of Civil Engineering and
Director of Road Department, University of Georgia.

*All lectures are to be given in Auditorium of Peabody Building.

- 10:30 A. M. *Sand-Clay and Topsoil Roads in Franklin and Vance Counties*—
W. S. FALLIS.
- 11:00 A. M. *Sand-Clay and Topsoil Roads in Craven and Wayne Counties*—
R. E. SNOWDEN.
- 11:30 A. M. *Sand-Clay and Topsoil Roads in Orange County*—R. T. BROWN,
Highway Engineer.
- 12:00 M. *Discussion of Present Conditions of Sand-Clay and Topsoil
Roads in North Carolina*—Discussion led by D. TUCKER BROWN
and S. D. SCOTT, Highway Engineer of Warren County.

WEDNESDAY AFTERNOON.

- 2:30 P. M. Inspection and study of samples of materials used in the con-
struction of Sand-Clay and Topsoil Roads.
Informal meeting in the Road Materials Exhibit Room, New
West Building—In charge of T. F. HICKERSON of the Engineer-
ing Department, and J. E. SMITH of the Geological Depart-
ment of the University.
- 3:30 P. M. MACADAM ROADS.
Is the Water-bound Macadam Out of Date?
Worn-out Macadam Roads: What Shall Be Done With Them?—
GILBERT C. WHITE, Consulting Engineer, Durham, N. C.
Bituminous Compounds in Road Construction—Representatives
of the Barber Asphalt Company.
- 4:15 P. M. *Contracts and Specifications*—BRENT S. DRANE, Consulting En-
gineer, Charlotte, N. C.

WEDNESDAY EVENING.

- 8:00 P. M. Entertainment, under auspices of the Community Club of Chapel
Hill.

THURSDAY, FEBRUARY 25.

- 9:00 A. M. MAINTENANCE OF ROADS.
Introductory remarks by Director of Institute.
- 9:20 A. M. REPORTS FROM COUNTY ENGINEERS, SUPERINTENDENTS, ETC.
W. S. Fallis, for Franklin and Vance counties.
R. P. Coble, for Lee County.
R. E. Snowden, for Craven and Wayne counties.
N. C. Hughes, Jr., for Halifax County.
Ira B. Mullis, for Harnett County.
R. T. Brown, for Orange County.
Sam D. Scott, for Warren County.
J. M. Pollard, for Durham County.
J. A. Davidson, for Guilford County.
D. P. Hutchison, for Guilford County.
R. A. Burnett, for New Hanover County.
Charles H. Neal, for Buncombe County.
J. B. Roach, for Iredell County.
J. B. Clingman, for Madison County.
James B. Price, for Rockingham County.
W. L. Wiggs, for Wake County.
W. P. Eddleman, for Cleveland County.

J. Roy Pennell, for Greene County.
 Wythe M. Peyton, for Yancey County.
 C. M. Miller, for Stokes and Rowan counties.
 J. W. Martin, for Edgecombe and Columbus counties.
 F. P. Tate, for Burke County.
 John Spinks, for Stanly County.
 D. S. Harmon, for Forsyth County.
 T. L. Ware, for Gaston County.
 J. M. Burrage, for Cabarrus County.
 F. G. Hines, for Martin County.
 J. C. Cooper, for Wilson County.
 J. N. Ambler, for Davie County.

- 11:00 A. M. Address by W. W. Crosby, Consulting Highway Engineer, of
 Baltimore, Maryland.
 Maintenance of Sand-Clay and Topsoil Roads.
 Maintenance of Gravel Roads.
 Maintenance of Water-bound Macadam Roads.
 Maintenance of Bituminous Macadam Roads.
 Maintenance of Dirt Roads.
 Suggested Systems of Maintenance.
- 12:00 M. *Methods Used in Maintenance of Capital Highway* (Illustrated)
 —D. H. WINSLOW, of the United States Office of Public Roads.

THURSDAY AFTERNOON.

- 2:30 P. M. BRIDGES AND CULVERTS.
Economy in the Design of Highway Bridges—
Relation of Contractor to the Highway Commission and to the
*Highway Engineer—*Engineer from Bridge Company.
Culverts: Terra-Cotta, Concrete, Corrugated Iron and Cast
Iron—
*Specifications for Culverts—*R. F. EZZELL, Chief Engineer of
 Maintenance, Southern Railway.
*Kind of Culverts—*By Representatives of:
 Pomona Terra Cotta Company.
 The Newport Culvert Company.
 The Carolina Metal Products Company.
 The International Clay Products Bureau.

THURSDAY EVENING.

- 8:00 P. M. *Good Roads in Other Lands* (Illustrated Lecture)—Professor
 COLLIER COBB.

FRIDAY MORNING, FEBRUARY 26.

- 9:00 A. M. *Blasting Materials.* A discussion of the different kinds of blast-
 ing materials and the most effective application of these to
 different classes of excavation—By Engineer from the DuPont
 Powder Company.
- 10:00 A. M. *Relations that Should Exist Between State Highway Commis-
 sion, County Highway Commission, and Township Highway
 Commission, and Relations of Highway Engineers to These—*
 By M. H. STACY, Dean of University, and JOSEPH HYDE PRATT,
 State Geologist.

12:00 M. BUSINESS MEETING.
How to Improve the Institute.
Correspondence Courses—Are They of Value?
Plan of Coöperation for the Employment of Engineers, Superintendents, and Foremen.

TUESDAY MORNING, FEBRUARY 23, 1915.

9:30 O'CLOCK.

Address of Welcome

The Institute was welcomed to the University by President Edward Kidder Graham, as follows:

Mr. President, Ladies and Gentlemen:

It is a great pleasure to the University to have you gentlemen back with us once more. There are a number of reasons that instantly spring to my mind as to why the University of North Carolina should welcome the Roads Institute as a permanent part of its activities. One of these is that you are good roads men—public good roads men—and I think that if we carry out our purpose at all we are not only in favor of good public roads, but of good public anything, that, in fact, is our business.

We are in favor, as I understand our business, of good public anything from the standpoint, not of emotion, but of knowledge. That is, we are trying to find out what things are true and of good report, and in a large way we are trying to find out why those things are so, and what is the best way of bringing those things about. Now, if I understand the object of the Good Roads Institute, it exists exactly and precisely for that reason. It is not only in favor of a good public enterprise, but it is in favor of finding out most expertly and exactly what that good public enterprise really needs to make it a better public enterprise. That is what I understand by education. It is translating a thing that people, in a vague and general way, consider to be a good thing into an actual, realizable fact.

The speaker then discussed briefly the enormous amount of money to be spent this year in the South in the construction of new public roads, and then continued:

If you will look at the great inventions of the last century or two, you will find that those great inventions and discoveries have all been concerned with one thing: they have been concerned with making more easy communication between man and man. If I should ask you the greatest discovery of the last century you would say, perhaps, the steamboat—making it possible for men to communicate with each other over the water. In some fashion we got the boat there and then human ingenuity tried to make that boat a better instrument of communication between man and man, country and country. We took a box and put it on wheels and we put power in those wheels and produced the locomotive, and we said we have got to make the road that that thing runs on a freer, more facile thing, a better communication between man and man. But we were not satisfied with that. We said we will take the air that is freer and more facile still, and we invented the telegraph; the telephone and wireless telegraphy.

Now I say that all of those things, all those discoveries and inventions, may be reduced to a single thing—the effort of man, through his ingenuity and intelligence, to make more communicable the good things of intelligence, bodily comfort and material welfare between man and man. We are interested in mainly one thing, and that is in making more communicable the good things that we have each found.

I suppose if a man would ask you the greatest public enterprise that has been realized in your recollection, you would say the Panama Canal. What is that? Nothing but an international good road. For what purpose? Why, for making more communicable the good things of the east and west. If I were to ask you what is the Atlantic cable, I suspect you would answer in the same terms: It is an international good road for flashing communication from country to country. To the wireless telegraph station, which we have up here in one of our buildings, you can go tonight and hear the latest thrill from the European war, or find out what sort of weather we will have tomorrow—a wonderful invention for putting men into communication with each other.

So, this educational institution is an instrument for making communication more facile and more powerful between this age and the last age, this country and another country. We are interested in the question of not only making water and air an avenue of communication—we are interested in the good roads of the spirit. That is our business.

When you come to roads, such as the one that runs in front of this building, you have there not nearly so romantic and interesting a project in the advance of the human spirit, but you have a practical and a workable instrument for bringing men into communication with each other. Certainly if it is not as stimulating to the human imagination, it is a tremendously serviceable instrument to the men and women of our country trying to find out how to live together most profitably and amicably.

One of the greatest discoveries of our own time, from the public point of view, is the discovery of the public good road as an instrument in good government. But I am not going to take up your time explaining the fundamental relation that the good road bears to the school, to the church, to the doctor, to the merchant, to the manufacturer. This has been done many times and it has been clearly shown that it is the necessary servant of all of our public enterprises. Our interest in the good roads now, and, for that reason, my particular interest in the Good Roads Institute, is not for purposes of exhortation and evangelization. We have a bigger problem than that of trying to convert somebody to the general doctrine of good roads. Of course that has to be done; but something else that a democracy demands of us that we do not so constantly bear in mind, is that when the public turns down many of our enterprises it turns them down not because it believes that our general idea is bad, but because we have not worked it out in terms the public is willing to accept. The public is a hard-headed person; it asks that its public problems finally be worked out in a scientific way.

The public road problem now is primarily one for the expert, for the scientist. It is for that reason public road institutes of this sort are extremely important. We do not need so much to be exhorted to believe that good roads are a good thing for the people, as to find out what sort of roads are good and why. It is to finding this out and finding it out under all of the complex conditions that affect the goodness of a road that you gentlemen

are giving a large part of your lives. The question of good roads is about the biggest question that the people of North Carolina have before them. They cannot answer that question except in a muddled fashion, for the simple reason that the complete answer is a technical and scientific answer that involves study and experience that belongs to the expert. Evangelization and popular propaganda for good roads is necessary, but it is only the first step; the solution of the problem of roads for the commonwealth depends on the difficult science of permanent road building that you have come here to study.

The telephone, the wireless telegraph, aeroplanes and all the rest of the instruments of human communication are romantic and thrillingly interesting; but the most important of these open avenues of commerce and friendship is and always will be the good country road. It has improved very slowly; it has been neglected and left to go where it chose and be as bad as ignorance and indifference could make it. But you are changing all of that and the people are giving you great sums of money as an expression of their confidence in the public road as a fundamental public utility, and in you as intelligent public servants, who will make the science of road building a field of genuine statesmanship.

Purposes of the Institute

JOSEPH HYDE PRATT, Director.

All of you consider this now as part of the University of North Carolina inasmuch as one of the new divisions of work that has been inaugurated here at the University for the past two years has been known as University Extension work. If there is any line of University extension work that I believe will do good, there is no line of University extension work that will do more good than that which the University is trying to do in connection with public roads. In holding the institute here at the University I think we have chosen as good a place as we could possibly find, because here we not only come in touch and bring together those who are interested in actual construction of the public roads, but we call to the attention of something over a thousand young men who are to become citizens of North Carolina that the public road question is of vital importance to the development of North Carolina.

Before we begin the regular lectures and discussions I wish to speak briefly in regard to the purposes of the Institute. My idea of the Institute has changed but very little from what it was last year, and I can sum up in just a few words my idea as to the purpose of the institute, and that is—that it shall be made a clearing house for road problems in North Carolina. That will take up every single phase of road work, and it is up to us, as President Graham has said, to work out and solve the problem—because if we do not do it, I know of no one else who is going to do it for the State of North Carolina. We come here as a group of men who are particularly interested in construction work. I am very glad to be able to say that we have with us those who are not as interested as we are, from the engineering standpoint, but are interested from the contractor's standpoint and from the manufacturer's standpoint of road supplies. We are not going to obtain the best results of road work until we reach that time when there is a just and fair working basis between those who have charge of the road construction work in North Carolina, and those who are supplying the materials with which that work shall be done. I hope, through the Institute, that we can become

acquainted not only with each other in the construction work, but acquainted with those who are in the end to furnish to us the materials with which we are to build our roads.

Now, in working out the program for this meeting it seemed, on account of the hard winter that we have just gone through, that perhaps we should try to emphasize more particularly this year the type of road which, notwithstanding the serious comments made in the newspapers, is bound to be the chief road in North Carolina for many years; i. e., the sand-clay, topsoil or gravel road. You will notice, therefore, in the program which has been distributed, that we have worked out a program that starts in with the first step in road construction work, location, and this afternoon we will discuss the question of the location, design and construction of roads. Then we take up in general the surfacing materials of the sand-clay, topsoil and gravel roads in which North Carolina is particularly interested; then we take up methods of construction and follow that through tomorrow morning and part of the afternoon. We go briefly into the question of macadam roads, for the reason that this question has come up in several counties: What shall we do with the wornout macadam road? Shall we try to repair that with water-bound or bituminous material, or shall we put sand-clay or gravel on it?

On Thursday we take up the question of maintenance of roads, and, particularly, of the sand-clay, topsoil and gravel. Then we take up a phase of work that is leading right on to the question of maintenance, because on it depends largely the reason why so many roads have gone to pieces during the past winter; i. e., the question of drainage. After this we hope to make the culvert question a most interesting discussion on Thursday afternoon—terra cotta, concrete, corrugated and cast iron—both from the engineer's and the manufacturer's standpoint. On Friday morning we will have a discussion of blasting materials; also of the relations that should exist between the State highway commission, county highway commission, and township highway commission, together with relations of highway engineers to these; and we close at noon with a business meeting. Three important questions will come up at that meeting: How to improve the Institute; correspondence courses: are they of value?; and plan of coöperation for the employment of engineers, superintendents and foremen. Can we arrange in connection with the correspondence courses offered here at the University a satisfactory course connected with the road problems of the State that the engineers, superintendents and foremen can take to advantage? I want to get the engineers, superintendents and foremen of road work in North Carolina in such close touch with each other that we can know where the good men are and, as they finish one piece of work, there is no question about transferring them to another section of the State or county to take up a similar line of work.

Last year we carried out a program which seemed to give pretty satisfactory results, at least to the extent that a resolution was passed asking that the Institute be made a permanent thing. All the papers and lectures which will be given at this institute will be open for discussion; and we have tried to arrange so that there will be plenty of time for the discussion of papers that come up. All are free to ask questions, and everybody is at liberty to ask to be helped out. That will give a little idea of what we are going to try to make the Institute this year. We take up this afternoon the location, designing and construction of roads. The first paper will be given by Professor T. F. Hickerson, Associate Professor in the Department of Civil Engineering of the University of North Carolina.

In the following pages are given the papers presented at the Institute and discussions of these papers (in so far as the stenographer was able to report them):

Considerations Governing the Proper Location of Roads

BY T. F. HICKERSON,

Associate Professor of Civil Engineering, University of North Carolina.

Good roads are intended primarily to supply means of communication and transportation from place to place with a minimum of effort and resistance and in the least possible time. The highest aim of roadmaking, we may say, is "endeavoring to help make smooth the paths of humanity."

There are mainly *three* things which make a *bad road*; *steep grades*, *bad curves*, and *uneven surfaces*; the first two of which are permanent obstacles to traffic due entirely to a *bad location* of the road. The first and most important step in the road improvement in this State, as well as in the South, is to correct the mistakes made by our ancestors and relocate the roads so well that future generations will never see fit to make any radical changes. Evidently the location of roads should be governed by engineering principles.

There are really a great many considerations which exert an influence on the location of roads, whether it be a revision of any existing road, or the lay-out of an entirely new route. The first considerations are *line* and *grade*, but they are influenced more or less by drainage, annual cost, exposure to the sun, character of the foundation soil, best stream and ridge crossings, traffic conditions, serviceability to the community, esthetics, right of way privileges, etc.

ALIGNMENT.

It is desirable of course to make a road between two points as direct and short as possible, but a deviation of a few hundred feet from the direct line in order to avoid a hill or a swamp may not increase the distance materially. Thus, Fig. 1, if a due east line $AB=2$ miles in length and C is a point 1,000 feet north of the middle of AB , then the distance ACB is only about 190 feet more than AB . See Fig. 1.

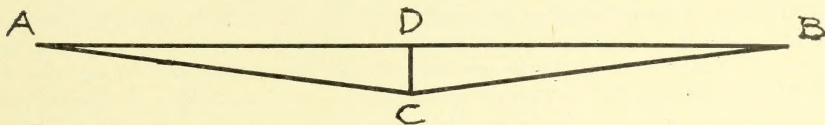


FIG 1

A slight curvature adds to the esthetic appearance of roads, but sharp curves are positively dangerous for modern traffic. New York State has adopted a minimum radius of 200 feet, wherever possible, with the result that the increased comfort has greatly pleased the traveling public. At the International Road Congress in London in 1913, it was agreed that the minimum radii of curves in roads used by fast traffic should, where practicable, provide an unobstructed view of 300 feet ahead, and where this is impossible, the curve being of too short a radius, means should be provided whereby the approach thereto is in some way clearly indicated.

In flat country, the controlling factor in the relocation of old roads is usually better alignment, that is, substituting smooth curves and tangents for sharp turns and zigzags, and at the same time, keeping on ground equally as good or better for grade and drainage. See Fig. 2.

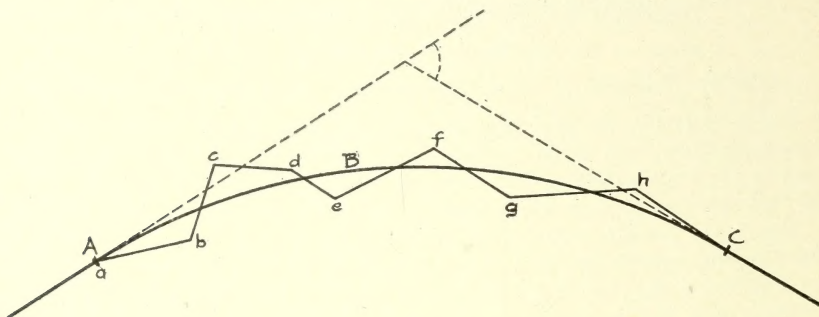


FIG 2

Thus, in Fig. 2, assuming that everything else remains the same, the long curve ABC may be substituted for the irregular line abcdefg of an old road which was originally laid out more or less by accident. Obviously it would be an unwise expenditure of money to build a sand-clay or macadam surface on such a road until the alignment is revised; yet there are too many cases where the public would say "let good enough alone" and attempt to improve the road surface which sooner or later will be abandoned when, say, the trees are all removed and the bad alignment is seen throughout just as an engineer would previously have seen it on a map.

GRADES.

In hilly and mountainous country, grades are the first consideration in road location. *Distance* must be sacrificed for grades. Formerly, very little attention was given to grades. Directness was the only consideration. Roads were located up and down hills when they might have been built around the hill with very little, if any more, first cost, and with a tremendous saving in the cost of transportation and maintenance. It is highly desirable that no grade shall be more than 4 per cent. As the grade increases beyond 4 per cent., transportation becomes burdensome and the erosion of the soil due to the increased velocity of surface water, begins to show marks of destruction.

Motor cars will pull heavy grades more easily than vehicles generally, and if it were not for the destructive effects of water, the matter of grade reduction would be less important.

DRAINAGE.

Drainage is the most important word in the road builder's vocabulary because it must be considered in connection with every phase of road building, be it location, construction, or maintenance. On account of better drainage, a ridge or even a side-hill location is preferable to a valley location. See Fig. 3, p. 19.

Too many roads have been located along the line of least resistance up the center of ravines until the head of the ravines is reached, and then up a heavy grade to the summit of a ridge. Fig. 3 shows how the location might

be improved by using a *side-hill location*, with better drainage and with a gradual upgrade to the summit of the ridge. The "valley route" would always be subject to the destructive effects of surface, as well as underground water, and therefore the maintenance cost (including repairs for bridges)

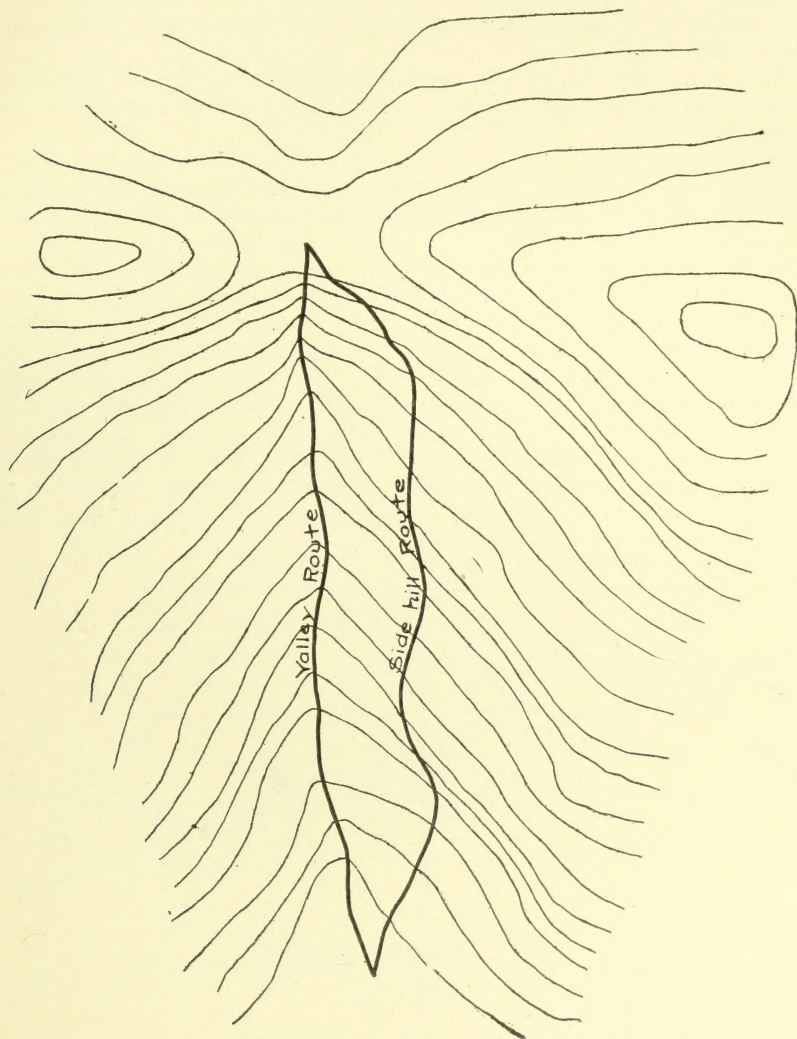


FIG 3

would be excessive. The "side-hill route," although slightly longer and perhaps more expensive in the first cost, has the advantage of remaining in good shape with comparatively little maintenance.

ANNUAL COST.

In considering the relative merits of two feasible routes for a road, the estimated *annual cost*, instead of merely the first cost, should be used as a

basis of comparison. The annual cost embraces the following items: (1) Annual interest on the first cost; (2) Annual cost of maintenance; (3) Annual cost of transportation; (4) Sinking fund for future repairs; (5) Sinking fund for extinguishing the original expenditure in a specified number of years.

The following illustration is an actual case that came within the experience of the writer:

Route No. 1 (see Fig. 4) follows an existing road which needs very little revision, but a river must be crossed twice and two 100'-span bridges will be necessary.

Length=3,500 feet.

Route No. 2 avoids the river crossings, but must cross over 400 feet of solid rock and then encounter side-hill construction and, finally, pass through the middle of a valuable farm.

Length 3,740 feet.

Route No. 1.

Cost bridges (life 30 years)	\$2,200
Cost abutments	1,000
Cost constructing road	500
Cost surfacing	300
	<hr/>
	\$4,000

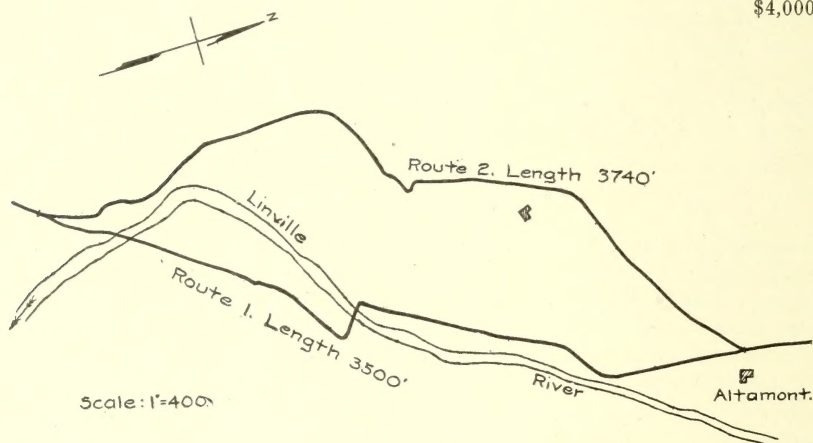


FIG 4

Route No. 2.

Cost construction	\$4,400
Cost right of way	100
Cost surfacing	400

Annual Cost of Route No. 1.

	<hr/>	\$4,900
Interest on first cost at 5 per cent.	\$200	
Maintenance of road and bridges	100	
Sinking fund for renewing bridges at 4 per cent.	40	
Insurance against destruction by flood 1 per cent.	40	
	<hr/>	\$380

Annual Cost of Route No. 2.

Interest on first cost at 5 per cent.....	\$245
Maintenance	50
Cost of assumed transportation of 10 tons per day over 240' at $12\frac{1}{2}c$ per ton per mile	20
	<hr/>
	\$315

Hence Route 2 should be chosen.

MISCELLANEOUS CONSIDERATIONS.

A sunny exposure and a porous foundation soil are highly desirable in order that the top and bottom of the road surface may be as dry as possible.

High stream crossings and lowest ridge crossings are often controlling points in the location of roads.

The traffic census of the road that is to be located and its relation to the road system has more or less influence in the location and a great deal of influence in the design of the road.

The location of a trunk line is not apt to be affected by local conditions other than topography.

Figure 5 shows the amount of territory that may be served by a highway between two cities, A and B, assuming that transportation on the minor roads costs twice as much as that on the main highway. Any road within this territory should be located at right angles to the main highway, AB, instead of straight towards A or B. See Fig. 5.

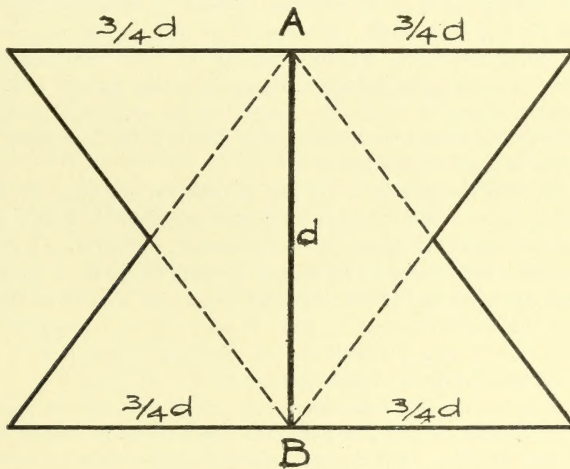


FIG 5

In locating certain roads, the question of serviceability to the local community must be considered carefully, but none of the technical requirements of a good road should ever be sacrificed. The following case will serve as an illustration of this point:

Between Snow Camp and Graham, N. C., is a long ridge which offers an ideal location for drainage, grade, and directness, but it would pass through an uninhabited territory and could not be reached easily by lateral roads.

The existing route, which admits of proper revision, leaves the ridge and passes through an inhabited territory. Evidently it is wise to relocate the old road, although it is not so ideal from an engineering point of view as the ridge route.

In conclusion, I should like to emphasize the fact that the location is the only *permanent* feature of road building and, therefore, it must receive careful consideration and foresight and preliminary investigations in order to satisfy *present*, as well as, *future* traffic requirements.

DISCUSSION.

MR. PRATT: One word in regard to the general problem of location brought out by Mr. Hickerson. The location is the only portion of your road in connection with construction that can in any way be spoken of as permanent, and for that reason, perhaps, as much as anything else, an engineer should be extremely careful that when he has made his report on the location of any particular road he has made the location that will not have to be changed in the future. In many instances there is a great deal of pressure brought to bear upon engineers, commissioners and superintendents in regard to the location of roads. I think the best illustration of the impracticability of deciding ahead of time where a road is to go is a bill that was passed some ten years ago by the General Assembly of North Carolina, in which the Legislature located a road in Mitchell County and stated that it should begin at a certain point. This was ten years ago; and that road has never been built.

Now, the personal consideration must not enter into road location. It is sometimes extremely hard to be entirely honest in locating roads, and probably there is no one who finds that consideration harder to overcome than the boards of commissioners, whether county or road commissioners, and it is the engineer who stands between them and the people. When a board of road or county commissioners has employed an engineer to look after the location of the roads over which they have control, the engineer must be the one to decide in regard to the location.

Now, we have had considerable trouble in several counties in regard to the question of location. I have simply told the engineer to make his report to his board and see that this report goes on record. The Attorney General has given an opinion that when an engineer is employed by a county to be in charge of road work he can insist that the report he makes shall go down on the records of the Commission; so that if there is any change made by the Commission in the location submitted by the road engineer it will have to show on the records of that Commission.

Now, as I have said, the location is the only permanent part of a road. The minute we begin to let the personal consideration affect that location or influence that location, we are not going to get the best location for the road.

I will speak a moment or two in regard to bond issues. The present General Assembly has passed already, I suppose, eight or ten county bills, some of which authorize an election for bonds, some instructing and directing the commissioners to issue the bonds for townships or districts, altogether something like nearly a million dollars worth of bonds being authorized already. The larger proportion of bonds are what are called long-lived bonds, running from thirty to forty years. To my mind such a bond issue in road construction should be used just as largely as possible in that part of the road which

we speak of as the permanent part of the road. Now, you have seen in the papers and road publications, some from the United States Office of Public Roads, information in regard to long-lived bonds, saying we ought not to issue road bonds for a longer period than the life of the road. Now the life of any road, so far as it depends upon the surfacing material, is probably just a few days after the time the road is built; because there is no type of road that does not have to be maintained. The surfacing material has to be repaired almost as soon as it is done. Take for instance, Fayetteville Street in Raleigh—this, representing the finest pavement, has to be repaired. In North Carolina, it would be impossible in many of our counties to issue for road work short period bonds; that is, bonds that would mature in ten or fifteen years, because the extra per cent that would be necessary to take care of a sinking fund and interest would require just the extra per cent to raise by tax that the people would consider impracticable. For instance, in this county (Orange) our bonds, consisting of \$250,000, run for forty years. We are taxing ourselves thirty-five cents on the \$100 worth of property to take care of these bonds. You cut that bond issue down to a fifteen-year bond issue and you would have to run your tax up considerably over thirty cents, so much over that you would not be able to carry the bond issue in Orange County. We did carry it with the expectation of running the tax up to 35 cents on the \$100 worth of property. With that idea in view—of the long-lived bond—I believe that just as much should be put in good location or the permanent part of the road, and that includes culverts and bridges, as possible. Therefore, when we consider all this, we can readily see that it is doubly important that the location shall be made permanent.

Economical Methods of Moving Rock

By W. S. FALLIS, Road Engineer.

In any discussion of methods of moving rock in road or other construction work, the local conditions must receive due consideration. What I am going to say is intended to apply especially to the conditions I have found existing in our State, and to the class of work that is needed on the roads in the sections of the State where rock is most frequently encountered. Some of the things which I shall define as economical under these conditions, could not be considered good practice under other circumstances, or in the case of larger operations.

In all rock work, no matter how it is prosecuted, the most expensive item of work is the drilling required to prepare the rock for blasting. There are several ways of drilling the holes for this purpose in common use. The two most distinctive are hand and power drilling. Drilling holes by hand may be done in several ways: (1) by hand-hammer drill; (2) by the churn drill; (3) by the rotary or auger drill. The last named drill is used only in very soft rock or coal.

The hand-hammer drill is the most commonly used of the hand drills. This drill consists of a piece of tool steel, usually hexagon but sometimes round in sections, from three-quarters to one and one-quarter inches in diameter and from three to ten feet in length. A bit of cutting edge is formed on one end somewhat broader than the diameter of the steel and a head for driving is made by annealing the other end. The bit is then carefully tempered to suit the kind of rock to be drilled. Different lengths of drills are used,

as the hole is deepened, for the convenience of the drivers. The operation of drilling is carried on by from two to four men, one man holding and manipulating the drill and from one to three men driving. Seven to ten pound (usually eight pound) "striking" hammers are used for this purpose. The handles of these hammers are made of the best hickory and should be very slender to secure the best results. Ten to fifteen feet of hole drilled per day of ten hours is about the average, according to the density or hardness of the rock. Eight feet is the usual limit in depth for a single hole, as the weight of the drill is too great for the man holding it to properly manipulate it for deeper holes. Experience has proven to me that three men, at one dollar and fifty cents per day, allowing fifty cents per day for sharpening and maintaining the drills, will drill blasting or bore holes in limestone or other similar soft rock for about thirty-five cents per foot of hole; or in granite or other hard and dense rock the cost will be about fifty cents per foot of hole. This is perhaps as good economy as can be obtained by the hand drill. Three well trained men form the most efficient gang for this work.

The churn drill is considered by some to be more economical than the hammer drill, and this is theoretically true, because the heat units lost between the head of the drill and the hammer in using the hammer drill are not lost in the use of the churn drill. However this may be, in practice the chief advantage of the churn drill over the hammer drill lies in the fact that deeper holes can be drilled with it than is possible with the hammer drill. Holes up to thirty feet deep are often made with the churn drill, and even deeper holes are possible. These drills when used for shallow holes are formed like the hammer drill, but have balls of iron or steel welded to them in order to give them sufficient weight to make them effective. In operating these drills they are simply raised and dropped by the men using them, the weight of the drill doing the work of cutting the hole. It is in very common use on railroad and other heavy rock work.

The chief object of this discussion is to call your attention to the amount of money that is so often wasted by the careless or ignorant prosecution of road work, when a considerable quantity of rock work is to be done, and to show that, by the use of proper methods, a large portion of this money could be saved.

The most economical method of drilling holes for rock work is undoubtedly by the use of some form of power drill. The steam drill, the air drill, the electric drill, the gasoline-air drill and the gasoline drill are among the many forms of power drills now on the market; and, under the various conditions of rock excavation, all of them have fields where they can demonstrate their economy. The air drill requires a somewhat expensive air compressing equipment and is often troublesome and expensive to move from place to place. The electric drill is practicable where current can be obtained. The gasoline-air drill is expensive and the gasoline drill still has some of the troublesome traits that distinguished the gasoline engine a few years ago. The steam drill, for the work most frequently met with in road construction, will, I believe, be found the most economical and satisfactory. This is largely on account of the small first cost of the equipment, and its equal efficiency when compared with other forms of power drills. A very good outfit, consisting of a drilling machine, hose and connections, drilling steels and sharpening tools, can be purchased for about four hundred dollars. If the county or contractor does not already own one, a suitable boiler can be rented at a nominal

cost. The drilling machine should be the size known as a three or three and one-eighth. This designation denotes in inches the diameter of the steam cylinder of the machine. This machine will drill from sixty to seventy feet of hole per day of ten hours, when properly handled, and at a cost of from sixteen to twenty cents per foot of hole, according to the kind of rock.

Comparing this with the cost of work by the hammer or churn drill, the economy of the power drill is at once apparent. The constant use of this drill for twenty-three days will pay back the purchase price, when compared with the cost by hammer drill, if the difference is only thirty cents per foot of hole. Experience has proven this to my complete satisfaction.

The following estimate will give a fair illustration of the economy of the power drill, when skilfully handled, as compared with cost by hammer drilling. In order that the estimated cost shall be entirely feasible and well within my own experience I will state a case that will produce a minimum amount of rock for the holing and powder used.

Assuming that we are working a quarry or lift of eight feet on open cut (not trench work) and the holes are spaced five feet from the face of the bench and five feet apart, this should give about one cubic yard of rock to each foot of hole. Assuming that the cost by steam drill is twenty cents per foot of hole or per foot of rock moved, that four cents will pay for the dynamite and that it will cost fifteen cents to haul to the dump each cubic yard of rock blasted, the total cost per cubic yard would be thirty-nine cents. Assuming again that the cost of drilling by hammer drill is fifty cents per foot of hole or fifty cents per cubic yard of rock moved, that four cents will pay for the dynamite, and that it will cost fifteen cents to move the rock to the dump, the total cost will be sixty-nine cents per cubic yard of rock moved. This shows a difference of thirty cents in favor of the steam drill for each cubic yard of rock handled. Since at thirty cents per cubic yard one thousand five hundred cubic yards would amount to four hundred and fifty dollars, I would advise any one to invest in a steam drilling outfit when there is any probability of having this amount of rock to move. The outfit would be more than paid for on the completion of this amount of work, and its value at the time would represent that much saved to the owner.

In preparing to load the holes for blasting, it is sometimes necessary to "spring" the holes. This is seldom required except in heavy work and is caused by the need for more space for the charge of explosives required. This enlargement or "springing" of the hole is accomplished by charging the hole with a small charge of dynamite and exploding same without ramming or packing of any kind. These holes are usually loaded with a combination charge of dynamite and black powder. In road and other light work, dynamite is generally used alone.

In selecting explosives for road work I would recommend that dynamite designated as "forty per cent" be selected and used exclusively. This grade of dynamite is of ample power for the work and is much safer in the hands of the inexperienced, and in fact in the hands of any one, than the grades containing a greater percentage of nitro-glycerine, and is perhaps the best all round powder for general use.

Dynamite freezes at a comparatively high temperature and, when frozen or even partially frozen, will not give good results. It is better to keep it from freezing than to have to thaw it out, but if frozen, great care should be taken in thawing. The use of fresh stable manure for this purpose, or a

double boiler using water at from ninety to ninety-five degrees (but no warmer) for filling the outside vessel is recommended. Never attempt to thaw dynamite before an open or any kind of fire.

The quantity of dynamite required for various kinds of rock and used under various conditions cannot be exactly stated and the amount of loading must be left to the judgment of the man in charge. It has been found, however, that in open cut work the charge need rarely exceed one-third of a pound to the foot of hole.

In firing the blasts there are two methods in common use, the "safety fuse" and the "electric blasting machine." The safest, and at the same time most economical method of exploding the blast is by the use of the electric blasting machine. This method gives complete control of the amount of explosion, saves the time of the men waiting for the fuse to burn, and makes "delayed" explosions impossible. An electric blasting machine capable of firing from ten to twenty holes simultaneously can be bought for from twenty-five to thirty dollars, including the required lead wire. Without considering the large element of danger thus eliminated, the economy of time required, as compared with the fuse method, will justify the cost of the equipment many times over.

The conditions surrounding the use of explosives are so varied that the best results can only be obtained by one who is thoroughly experienced in this work, and I would earnestly recommend that such a man always be put in charge of blasting operations when any considerable amount of work is to be done.

Hauling the rock after blasting is another element within the province of this question. The average distance necessary to move rock in road work is seldom more than one hundred and fifty feet from the point where it is blasted. I have found the old and familiar one-horse dump cart to be the best and most economical method of handling this part of the work. The reason for this is two-fold; the ease and rapidity with which it can be dumped and the facility and speed with which it can be replaced for loading. No other means for handling this material can be so easily put at just the right place for loading or so quickly emptied at just the right point. The cost of moving rock by this method can be described as follows: Two carts with two horses or mules will cost about two dollars and fifty cents per day, five loaders, one driver, and one dumper each costing one dollar and twenty-five cents per day, making a total cost of eleven dollars and twenty-five cents per day. Five loaders will load one-half cubic yard of rock in a cart in about four minutes. Allowing one minute to travel to the dump (a distance of from fifty to one hundred and fifty feet), one minute to dump and one minute to return and get into place for loading makes eight minutes for a round trip for each cart. This keeps the loaders busy, the driver busy, and the dump man, with perhaps only a small margin of time to spare. Moving one-half cubic yard of rock every four minutes will mean seventy-five cubic yards moved per day, which makes the cost of this part of the work fifteen cents per cubic yard.

In moving rock from macadam work or other construction work where the haul is long, say from one to four miles, an entirely different condition confronts us, and an altogether different method must be employed. During the construction of the macadam road work in Wilson County in this State, I found that a maximum haul of seven miles would be required. This was

prior to the development of the many efficient hauling outfits that are now on the market. This work was done under contract, by the use of mules and wagons. The wagons were built by the Hackney Wagon Company of Wilson especially for this work and were of eight thousand pounds rated capacity. The bodies of these wagons were of the "stick" variety, and held three cubic yards. These wagons were loaded with an average load of four tons of crushed rock, and four large mules handled them very readily. The hauls under this contract were from one to four miles in length and the cost of the work was eighteen cents per ton mile. This paid the contractor about six dollars per day for his team of four mules and driver. The loads were dumped into the wagons from the crushed bins, and unloaded by removing the slats of the "stick" body. The time consumed in loading did not figure largely in the cost of the work owing to the length of the hauls.

In an article published in October issue of *Better Roads* in behalf of the Troy Wagon Company, of Troy, N. Y., there is made, in tabulated form, a statement from which the following is taken: "A motor truck test shows that, for the distance given in the Wilson work, this truck hauled stone at a cost of twenty-five cents per ton mile. With one trailer truck the cost was fifteen cents per ton mile, and with two trailers the cost was reduced to thirteen cents per ton mile." In considering the economy of the use of motor trucks for hauling material there are many things that should receive attention. Among these I will mention only one as being especially worthy of the attention of the road builders here, and that is, the destructive effect on our roads of the heavy weight on the rear wheels of the motor truck. Will the damage thus done to the roads be equalized or overcome by any economy in the use of the truck? In my opinion the medium or light weight tractor, with the load weights divided up among several trailer trucks, will soon demonstrate that it is a much more economical means of hauling material than the motor truck or heavy tractor now in use on many roads. I believe that this will certainly prove true when we give due consideration to the maintenance of our roads. I am quite sure that as an investment a medium or light weight tractor will be a more efficient tool than the heavy machines now on the market, for the various purposes to which it could be applied in road construction and maintenance.

Economical Method of Handling Surfacing Materials in Road Construction

By R. P. COBLE, Road Engineer.

The most essential thing in the determination of results from the use of any particular method of handling surfacing materials, is the efficient application of the method, based upon practical and economic principles. Probably there is no one best method for any given set of conditions, or one method applied to one condition economically could not be so applied to another. Therefore, it is the first duty of the highway official to study carefully the various methods and the nature of the conditions to which they are to be applied. In doing so he must consider the type of equipment coincident with each particular method, whether hauling is done with wheel scrapers or with wagons, with traction outfit or with motor truck, and the application of each of these to the different local conditions to which they may be subjected.

The cost of hauling may then be determined by the various factors involved, for any given piece of work, and the economy of the different methods compared.

1. Cost of operating the outfit, including interest on investment, depreciation by wear, maintenance and supplies, such as repairs, fuel, oil, etc., and labor necessary to operate it.

2. The amount of tonnage, or capacity of the outfit per trip.

3. Speed of the outfit used, or rate of travel.

4. The length of haul, or distance of the material from point of application.

5. The amount of time lost while loading and unloading, and also time lost due to the condition of the roads over which the hauling is done.

The industrial railway might also be considered here, but since the items of equipment previously mentioned are the ones largely used in road construction, especially in the Southern States, are all that will be considered in the scope of this paper. Average conditions should also be implied, as the cost of operation of any machine should be taken from the average of many runs under normal conditions and not from exceptional runs made under the most favorable conditions, such as conditions of water, roads to be hauled over, and the general efficiency exercised in operating. All of these various conditions tend to decrease the efficiency of the outfit in the proportion to which they are applied, and vice versa.

The materials used in surfacing will also determine to some extent the type of equipment or method to be employed. We could not use wheel scrapers with economy in macadam surfacing, while, I believe it will be generally acknowledged that wheel scrapers are the most economical when gravel or sand-clay is used, and the length of haul does not exceed a thousand or twelve hundred feet: (1) because they are easy to load and unload; (2) because the surfacing material can be more evenly applied by this method than by wagons, motor trucks, or traction outfit; (3) because this equipment is necessary in grading and is generally on the job. Hence it is economy from the standpoint of adaptability to various classes of work. While other methods might be employed for the haul of twelve hundred feet producing more efficiency, yet, to employ these methods would necessitate the purchasing of another outfit, and the outlay of more money in equipment, without knowing, possibly, where it would be employed next. For that reason it is more economical to use a reasonably efficient method continuously rather than a special and highly efficient one for a certain kind of work and have it idle for a large percentage of the time.

Considering the various factors previously mentioned and enumerated in the cost of hauling, the wheel scraper is especially applicable to at least two of them, low cost of operating, small amount of time lost in loading and unloading, which is indispensable for short hauls. It might also be added that for conditions as they exist especially in the South where the material for surfacing is obtained from the adjoining fields, and clay obtained from pits opened near the roadside, it is more nearly fitted to meet these conditions with lower cost than any other method for handling to be employed.

When the length of haul exceeds the limit for the wheel scraper other methods should be introduced, and the one producing the greater efficiency from the standpoint of first cost, output, etc., adopted. To ascertain this, it is necessary to compare the various methods for certain lengths of haul, and consider the varied factors making up the cost of hauling pertinent to each of these methods.

The cost of operation will vary as said before with conditions of the weather, roads, skill exercised in operating, the outlay for equipment plus

upkeep of same, the labor necessary to operate, including loading and unloading. While the values assigned can only be taken as closely approximate for average conditions, they will perhaps aid in comparing the cost of hauling in each method, and are as follows: Cost of teams when wagons are used, 60 cents per hour; for motor truck, \$2.75; for traction outfit, \$3.50.

The capacities of outfits also vary, but it is the aim to consider only those in common use as a basis for comparison; wagons for team hauling 1½ tons, motor truck 5 tons, traction outfit 15 tons.

The rate of travel is practically the same for all outfits of any particular types, though this varies somewhat with the condition of the roads, however, there is an average that may be taken as a value and meets generally the conditions as they exist; for teams three miles per hour, traction outfits three miles, motor trucks ten miles, assuming that half the distance is travel loaded and half unloaded.

The length of haul of course, is the same for any particular piece of work.

The amount of time lost depends entirely upon the methods used in loading and unloading the outfit. If the quantity of material at any particular place is sufficient to justify the use of a bin or trap for loading, or if extra cars of the equipment are loaded while others are on the road, very little time need be lost. The extra cars are a necessity especially in traction hauling, and unless these can be provided for, the traction outfit would not be a practical one to use. Any time lost while loading and unloading is very expensive and should be eliminated as much as possible. The following amounts of loss of time per trip will be nearly enough correct to get a comparison of results, and are as follows: For team hauling when shovels are used in loading, 15 minutes; motor trucks when loaded from bins or traps, 8 minutes; and traction outfits, 30 minutes.

Knowing the relative parts that enter into the cost of hauling and handling surfacing materials and the relation existing between them, the cost per ton may readily be computed from the following equation for any length of haul, and the results compared as follows:

$$*C = \frac{rd}{ns} + \frac{Tr}{n}$$

Where

$$C = \text{cost per ton for length of haul} = \frac{d}{2}$$

d = distance in miles per round trip.

n = number of tons hauled per trip.

s = speed of outfit in miles per hour.

t = time lost loading plus time lost unloading.

r = cost of operation in dollars per hour.

By inserting the values of the various factors making up the cost of hauling in the above equation for each method we get the unit cost by that method

for any length of haul — which are as follows:

$$C = 0.133d + 0.100, \text{ for team hauling.}$$

$$C = 0.055d + 0.073, \text{ for motor truck hauling.}$$

$$C = 0.077d + 0.116, \text{ for traction hauling.}$$

*This equation taken from abstract of paper in Engr. News by Prof. Agg. University, Illinois

By inserting the values of d and dividing these values by 2 for the length of haul in the three above equations, we get the following results, or cost per ton by the various methods, for the length of haul in question:

	Half mile.	One mile.	Two miles.	Three miles.	Four miles.	Five miles.
Team hauling	\$0.166	\$0.233	\$0.366	\$0.499	\$0.632	\$0.765
Motor hauling .....	.101	.128	.183	.238	.293	.348
Traction hauling .....	.155	.193	.270	.347	.424	.501

The above values are computed for comparing the cost of handling materials by the three methods mentioned above, and while some of them were taken in the field and are nearly correct under the conditions the outfit was working at the time, others were assigned from the best available data at hand. If the values inserted in the above equations are not applicable to a given set of conditions, others can be taken that are fitted and computations made for comparisons, in determining the most economical method to employ for the conditions being dealt with.

An experienced man must be put in charge of either method employed if satisfactory results are to be obtained. This will apply just as forcibly to the team method as to the motor truck or traction. He should be a man that can quickly grasp and solve any problem that is liable to occur in hauling, such as delays due to some part of the outfit being impaired, or other unavoidable causes resulting in delays. In team work the teams should be kept so regulated on the road, as not to have more than one team loading or unloading at the same time. The idea is to get the greatest efficiency from minimum cost. To do this, just a sufficient number of teams should be employed to keep the loaders loading continuously, and no more. Time lost by wagons waiting at the borrow pit to be loaded is money lost, and should not be tolerated. No given set of rules can be handed out to meet all conditions as they occur in the field. For this reason the superintendent or foreman must rely upon his initiative to meet the conditions as he finds them.

No one of the methods mentioned in this paper is applicable to all the varied conditions as they exist, and while one cannot be used economically, another can. The one more nearly uniting all the requirements from standpoint of cost and results is the one that should be considered, and if found practical and well adapted to conditions as they occur, adopted.

The Effect of Grades Upon the Design and Location of Roads

By D. TUCKER BROWN,

Road Engineer and Director of North Carolina Good Roads Association.

Any point in the center line of a road is determined by its horizontal and vertical position with reference to some fixed or starting point. The first, or horizontal position is determined by the alignment, and the second, or vertical position is determined by the grade. It is therefore possible to alter the center line of any road so that it will meet the conditions imposed by any change of alignment or grade, and any change in the alignment or grade will necessarily alter the center line.

It is the effect which any grade or change of grade might have on the final location of a road, considered from a point of economy, that I will discuss; but before doing so, wish to review briefly the costs attached to roads, in order that I may more clearly show how each of these costs is affected.

Roads, as do any other from of construction, represent an expenditure of money, either by an individual, a corporation, or the public; the capital necessary, depending entirely upon the execution of the work, and the requirements of the plans and specifications. It matters not in a completed road what the cost of construction was. All that is left to represent the money invested is the road itself, and it is the care to be taken, and the use to be made of this, that determines whether or not the investment has been made wisely or unwisely. The construction is accomplished by various methods; it makes no difference which, some one has to "foot the bills."

It has been frequently said, and too often I think, that money has been wasted in the construction of roads. Whether that be the case or not, the proper course to pursue after the road is finished is one of vigilance and perseverance, in order to protect that which has been invested. The only way that this can be done is by an adequate and efficient system of maintenance, for the only source on public roads, (other than a direct tax), from which the interest on the cost of construction and cost of maintenance can be paid, is the money which is indirectly saved the public, by the difference in the costs of transportation over improved and unimproved roads.

The cost of transportation depends upon the costs of construction and maintenance, but when maintenance is necessary, construction has ceased, and if the maintenance is neglected, the only source of revenue, (indirect as it may be), is immediately throttled, and the road becomes a burden, to be borne by the taxpayer, out of a pocket which is not being replenished by the same agent which is emptying it.

On most roads a pretense at maintenance is made during certain seasons of the year, and this, frequently, if not always, costs more than a system of maintenance that would bring good results and revenue. This accounts to my mind for the cry, "money wasted in construction," and it is not remarkable that the public should be dissatisfied and aggravated, when they are paying directly, two taxes, the costs of construction and maintenance, and indirectly, the cost of transportation, which, instead of being a tax, should be a source of revenue made possible by improvements.

The locating and designing engineer has the problem of properly adjusting the costs of construction and maintenance, and consequently that of transportation, so that the road improved according to his plans will be a revenue producer. It is the effect which grades have on these costs that I shall consider.

As has been said before, grade is one factor upon which the final location of a road directly depends, and it has a more subtle effect upon the costs than does alignment. It is an easy matter for any one to see that time is being lost when he is traveling two miles to reach a point one mile away, but it is not so easy to understand the difference in the cost of moving a load up a two per cent and a six per cent grade.

EFFECT OF GRADE UPON THE COST OF CONSTRUCTION.

The cost of construction may be divided into three separate and distinct costs, the cost of drainage structures, the cost of roadbed, and the cost of the surface, all of which are more or less dependent upon grade.

DRAINAGE STRUCTURES.

The design of drainage structures is governed largely by the difference in elevation of the grade line, and the original surface of the earth at the point

where the structures are to be used, consequently their cost varies with any and every change of grade. There is no method of determining in a general way the cost of a structure for any specified drainage area. Each stream crossing and drain should be taken care of by either a bridge, culvert, or pipe, the designing of which has been made to suit the conditions imposed. The properly located road will, therefore, cross streams and drains in a way that will permit the use of economical drainage structures.

ROADBED.

In the construction of any roadbed, the total yardage of material and the points to which and from which it is to be moved, are fixed by the alignment and grades, that have been established. The total cost of excavation is, therefore, directly dependent upon the alignment and grade, and it is affected most (properly located roads being considered) by grades in level country and by alignment in mountain country, for in practically level countries any change of alignment would require negligible changes in grade to obtain the same excavation as was necessary before the change; but in mountainous sections just the opposite is usually the case.

If grading is not properly done, grades may affect further the cost of the completed roadbed, for on new construction the embankment and exposed slopes are easily washed by running water; and if the grades are steep, the velocity of the water is materially increased and much damage may result unless the proper precautions are taken for getting rid of the water. After the road is complete, grass, honeysuckle, vines or some other growth will be a great protection to embankment and slopes.

SURFACE.

The cost of surfacing a road is dependent to a large extent upon the distance the surfacing material has to be hauled. A part of this distance is usually along the road upon which the material has to be deposited, and it is over this section that the cost of hauling is affected by the grade of the road under construction. It is much more economical to have the wagons loaded with surfacing material travel down grade or up slight grades, than to pull a part of a load up a steep incline. This is a transportation cost but, since it has to be paid out of the capital provided for the construction of the road, it is also a construction cost. Engineers should consider this when locating the surfacing material for the road.

EFFECT OF GRADES UPON MAINTENANCE.

The cost of maintenance like that of construction may be divided into three costs, the costs of maintaining drainage structures, roadbed, and surface.

DRAINAGE STRUCTURES.

The cost of maintaining drainage structures is not affected at all by the grades, *provided*, however, plans have been properly made and the structures built accordingly.

ROADBED.

The cost of maintaining the roadbed is dependent to a large extent, if not altogether, upon the action of water, which on steep and level grades is much more severe than on medium grades.

Water may be destructive either when in motion or at rest. It is moving water on steep grades, and water at rest on level grades, that has to be provided for. The deleterious effects of water may and should be foreseen and prevented to a large extent by the locating engineer.

The fact must never be lost sight of, that adequate drainage is always *necessary*, and must receive the locating engineer's first consideration. Steep grades, as do level grades, necessitate expensive drainage systems. The medium grades are therefore preferable.

The rain water which falls upon the surface of a road before it accumulates in the ditches has its effect upon the shoulders, and, if the grades are steep, the tendency is for the water to follow the road longitudinally instead of flowing to the ditches. This can be best prevented by maintaining the lateral grade (crown) of the road steeper than the longitudinal.

SURFACE.

The cost of maintenance of the surface of roads is greatly increased by any increase of grade, which is mainly due to the difficulty of keeping the crown always in a condition that will permit undisturbed drainage to the ditches. This is especially hard on steep grades, when it is realized that it requires much more tractive effort to move loads up grades than on a level. There is always a tendency for the surface material to become loosened and displaced by the constant "downhill pull" of the traffic, and, unless the surface is carefully watched and kept in place, water will begin to seep through and soften the sub-grade or foundation and eventually undermine the road.

EFFECT OF GRADES UPON TRANSPORTATION.

As mentioned before, the cost of transportation is of paramount importance, for it is the saving in this cost that provides the funds for paying the construction and maintenance costs.

There are at present two principal methods of transportation, by motor vehicles and by horse-drawn vehicles; and as they are so entirely unlike, and the effect which grades have upon the cost of each so different, it is essential that they be considered separately. As this paper deals only with the economical effect of grades, I shall not consider the transportation of pleasure vehicles as distinct from freight vehicles.

TRANSPORTATION BY MOTOR VEHICLES.

Motor vehicles can with apparent ease ascend a continuous grade of ten per cent, no matter how long it is. The only appreciable loss in going up grade is that due to the decreased speed, the additional amount of fuel consumed, the increased wear on tires, and the wear and tear on the engine. The loss due to the decreased speed is hardly worth considering, for most motor vehicles can carry their maximum load over any improved and hard surfaced road at the maximum speed allowed by law in most states.

The amount of fuel consumed in going up a grade, over and above that which would be used on a lesser grade, represents a loss due to excess grade; but if the grade of the road is undulating or sinous, a great deal of the fuel which would be lost can be saved by coasting down one hill and allowing the momentum so acquired to help propel the vehicle up the next. I am of

the opinion that it would take no more fuel to propel a motor vehicle over a road, the grade of which was as shown in A, than it would to propel it over a road the grade of which was as shown in B. See Fig. 6.

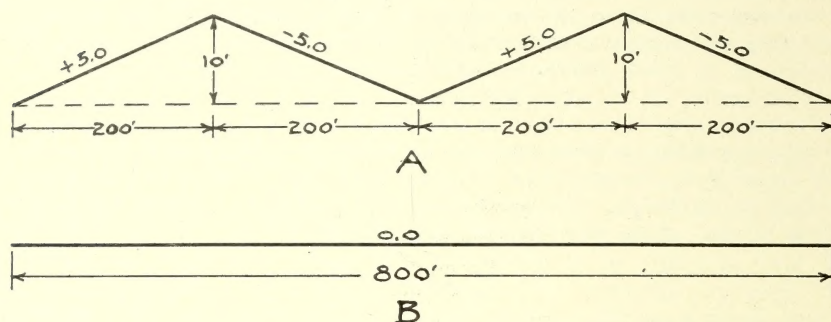


Fig. 6

Again the amount of fuel necessary to operate a motor up a 10 per cent grade, over and above that necessary to operate it on a level grade, is to some extent compensated for by the increased speed maintained on the level grade. This would be a total loss, however, if the speed up the 10 per cent grade were the maximum allowed by law and the motor driver were required to stay within the speed limit on light and level grades. The wear on tires due to pulling up heavy grades over that due to lesser grades, I think, can be considered practically in the same manner as fuel consumption.

There is one other effect of heavy grades on motor traffic, and that is the wear and tear on the engine, which I think should be negligible, provided the engine has been properly designed. I do not therefore believe that motor traffic is seriously affected by grades up to 10 per cent, provided they are not too long.

TRANSPORTATION BY HORSE-DRAWN VEHICLES.

This presents an entirely different problem from the cost of motor transportation. There is a limit to the amount of work a horse can do, and we are powerless to materially extend that limit. It is impossible for a horse to produce momentum in descending one grade that will assist him in climbing the next; in fact, there is a great deal of energy expended by a horse in descending grades, and especially steep grades, and if hastened down them permanent injury may result.

The maximum grade that can be economically used for horse-drawn vehicles is undoubtedly less than it is for motor-drawn, and therefore horse-drawn vehicles should receive first consideration by the engineer.

The maximum grade which it is economy to use for horse-drawn vehicles varies with the character of surfacing of the road, for the rolling resistance is dependent upon the surface, while the grade resistance is not. The best authorities give the maximum grade for earth roads as 7.5 per cent and for macadam at 2.2 per cent.

The only effect that grades have upon the cost of transportation by horse-drawn vehicles is due to reduced load, for the maximum load that can be hauled over a certain road, is the maximum load that can be hauled up the

steepest grade. This cost can be obtained in dollars and cents, but I do not consider that necessary, or within the province of this paper.

In conclusion, I will say that no engineer will regret it if he gives his undivided attention to the cost of grades before undertaking the construction of any road.

DISCUSSION.

MR. FALLIS.—In connection with that, in building or making these locations, it is a wise thing to get the location and build, finish and grade the road in such a way that if we intend to put a more valuable surface of bituminous macadam on it, there will be no necessity for further grade work. The original foundation is built with bond money. That is one thing I try to emphasize in my work.

MR. PRATT.—In many sections of North Carolina it is the traffic that should determine the surfacing material. As the traffic increases and demands a harder surface, there ought not to be any question that you have got to change the location, because you have not a foundation that will stand heavy traffic. That is one of the principles that should govern the location that we are building for the future. We all know that as the traffic increases and the demand for heavier surfacing material increases, there is never any trouble to find money with which to put down a heavier surfacing material, because increased traffic means increased wealth in the community.

MR. SPOON.—An idea occurred to me in relation to bond issue in road location. That is, since the location is the one permanent thing and since population increases, it is extremely wise when a bond issue is made, that as much as possible of the main system of a road be fixed permanently. The difficulty of getting a right location is daily increasing.

MR. PRATT.—This year I have had included in the local county bills introduced in the General Assembly that before any road work is done in new counties taking up road work, there shall be made a road survey of the county, to get the engineer and commissioners to become familiar with the county as a whole; determine the location of the people of the county, its topographic condition; the relations of its roads to those of the adjoining county, etc., so they will know what are going to be the main traveled highways. This includes not a complete traffic survey but a fair, comprehensive idea of what the particular county and those who have never considered that point will be surprised when you find the very high percentage of the traffic that goes over the very small percentage of roads in the county or township.

MR. PRATT.—One more point in connection with the location is the location of a road on the north or south side of a mountain. There is a difference in the cost of maintenance according to the side of a mountain or hill on which the road is located when the question of shade comes in. This has very little to do with the actual location problem but has a great deal to do with the question of maintenance of gravel, sand-clay or topsoil roads. We have tried to include in the bills a provision for a right-of-way which will permit the commissioners to cut back where they go through a wood a sufficient number of trees to permit sunlight to come in so that the road can be easily dried up.

Economical Methods of Moving Earth in Road Construction

By N. C. HUGHES, JR., Road Engineer.

In all classes of road construction there is ever one proposition that has to be dealt with: one so real that it easily may be termed the differential

which governs the ultimate cost of a completed highway. And this proposition is that of moving earth, better known in construction work as excavation. The natural consequent to this proposition therefore that should be sought is that of "The Economical Methods of Moving Earth in Road Construction"; and this is properly always considered from a yardage basis. So let us discuss briefly this subject, first from a view general, and then from one specific.

Generally speaking, the conditions attending earth work in the construction of highways vary considerably and are materially different in different localities. In the mountainous region, besides the rock problem, there is found an earth full of loose rock which cannot be classified as rock work, but is very heavy earth work, full also of gravels of varying sizes with a heavy, sticky red clay which offers a very tough resistance in being moved. In the Piedmont sections there is a combination of soils; a topsoil either of very coarse grit with some gravel, or of pure gravel or of clay-gravel, or pure gravel-clay quite stiff and lumpy when once loosened up, either as a top soil or subsoil excavation. There is found a stiff, bull-wax clay, or a buckshot clay under the top soil. In the tidewater sections the principal soils are, for the topsoils, sand-loam, pure loam, and pure sand, with now and then a pocket of grit so coarse that it might be called gravel; for the subsoil, a silty reddish clay or pipe clay, or a yellowish silt-clay. These varying classes of earth are here mentioned to show wherein the cost of moving them is of course bound to be more or less to a degree according to the location of the material.

Before going further, however, let us understand that all the figures appearing in this discussion are based upon a unit which bears the total expense of operating and maintaining an efficient outfit for grading, except where otherwise hereinafter specified; also upon the basis of a county or township owned and operated outfit, for under proper management it is undoubtedly cheaper to handle earth with such an outfit than it can be done by contract. Also with labor graded from \$3.50 for the superintendent or main foreman down to a dollar per day for the water boy; interest on the capital invested; allowance for deterioration of the equipment per month; and the current expenses attached to the whole operation.

To return to the subject of economics, before undertaking any great amount of excavation, it is best, (1) to investigate the surrounding conditions and the nature of the work and, (2) to figure about what amount of money may be legitimately allotted to this portion of the work to be undertaken. If the finances and the extent of the work will so justify, and where the excavation is quite heavy and frequent, in the end, no doubt, the economical thing would be the installation of an automatic steam shovel of at least a yard capacity and its accessories. It is possible under proper manipulation of the shovel and the team work to move earth for from five to seven cents per cubic yard, provided the haul does not exceed six hundred feet on an average; and with the shovel alone on excavation to be wasted, or on hillside cuts, it should be moved for from three to five cents per yard. While this outfit is apparently economical perhaps only on work requiring a removal of from five to eight thousand yards per mile or more, with at least a year's work to be done, to admit of the outlay for the installation, I believe still the time is not far distant when the road work throughout the State will reach such proportions as will not only justify but demand a very extensive use of the

steam shovel. But under present conditions, principally financial, it appears on the face of things to be out of the question to depend mainly upon a steam shovel for excavating purposes.

Granted therefore that we must of present necessity abandon any thought even of the general use of this machine in our present method of road construction, let us turn to other means more within reach of the funds provided therefor, and more adaptable to the conditions to be confronted and dealt with. Here again must conditions be thoroughly looked into, both those financially backing the project and the physical ones actually to be contended with.

Granted then, to be specific, that the finances are sound and sufficient, that there is an average per mile of two thousand yards or more of excavation necessary for required grade, with the material to be moved varying in classification from loose rock to sandy loam, so balanced as to give an average haul from cut to fill of five hundred feet, and one not over two hundred feet for waste. Under the above conditions, I should say, the most economical method of moving earth is by means of teams and wheelers. This being the case, it is proper to base calculations for the cost of moving earth on what the snatch team can do per day or per month, preferably per month, as this length of time will include the overhead. The proposition is to keep enough wheeler teams on the job to keep the snatch team busy loading one and almost immediately turning to load another, whether five or ten wheelers are required for such an operation; the longer the haul of course the more wheelers, about one to every additional one hundred feet beyond a five hundred feet free haul and up to one thousand feet free haul.

Where the excavation is continuous it is always economical to equip the outfit with a number one class of team as well as with a number one grade of machinery. Then, to go more into detail, the cheapest method of moving earth is by means of a 4-up snatch team loading wheelers of a size No. 2½ with carrying capacity of seventeen cubic feet. This outfit will move upon an average of eighty-five hundred to nine thousand yards per month, or twenty-four working days out of the thirty, at a cost per yard of from thirteen and a half to fourteen and a half cents; with convict force from ten to eleven cents. It is possible to move earth quite cheaply with a 3-up snatch team also, loading wheelers of size No. 2, with carrying capacity of from twelve to thirteen cubic feet. But since it is obvious that the 4-up team will move a third more earth than the 3-up team with but little additional monthly expense, the conclusion is that it is cheaper to be equipped with the heavier team and the heavier machinery. In passing this proposition let me say that no doubt the excessive cost at times of excavation in road work is due in a large degree to a lack of proper equipment. To be lacking one or two teams in the proper handling of earth work is a great deal more expensive than the overhead expense of carrying one or two teams for the purpose of running them in when needed.

There are conditions under which it is very economical to move earth with the ordinary drag scrapers of five to seven cubic feet or a Buck scraper carrying eight to ten cubic feet. But the work must be either a swap-over proposition or not have a haul of over two hundred and fifty feet, and too, the material must be rather light. Work of this character with these scrapers should easily be done for six to eight cents per cubic yard. Upon the whole, however, these instruments are merely adjuncts to the whole equipment and by no means sufficient alone for an excavation outfit.

We now come to the consideration of the use of the road machine or grader for excavating material. In case it is to remove rapidly the top of an old worn roadbed to a depth of four or five inches to be replaced by good surfacing material, where the location and conditions will at all permit, the cheapest operation on this is with a six- or eight-horse road machine. By this method, however, the material can be removed only to either side of the road. Under ordinary conditions this class of earth work can be done for from three to four cents per cubic yard. The road machine also does very economical work in cutting off bumps and filling in holes in the preparation of the sub-grade for the surfacing material, or, as it may be termed, scrape-excavation. The use of the road machine is also a very economical method in excavating hillside cuts either in half-way or two-thirds work, up to the point where the wheeler or the slip scraper comes in as the cheaper method for such removal. The same may be applied to mountain work of this class. Allotting to this operation its legitimate part of the burden of expense, earth can be moved by this method for some five or six cents per cubic yard under ordinary conditions. In this class of work, too, the Buck scraper will give very efficient service, moving earth for from eight to nine cents per cubic yard.

While moving the material for surfacing roadways is a form of excavation, it is in a class distinctly by itself, as we will soon be shown by one of our number present this afternoon. Still in road construction, general excavation and moving of surfacing material must of necessity be taken care of by a combination outfit, since they are interlocked to such an extent that one cannot be considered without the other.

Finally, let me say, that the personal equation plays perhaps the most important part in the economical method of moving earth. That is to say, it rests largely with the foreman or superintendent of a grading outfit as to how much or how little an outfit will move in the run of a month, which of course governs the cost of the yardage. As in any other work or business, the trained mind, or the mind with a natural bent for a certain work or a certain business, counts for economy or success; so too in road construction, and in the moving of earth, particularly, the trained mind, one with a foresight for the main chance to get ahead always is worth far more to the job than the cost of that skill will be an expense. One man can take the same outfit and under the same conditions move twice as much earth in a given time as another one can, by reason of his foresight and his skill as a manipulator of labor being far superior to that of the other. Organization first under a competent superintendent, then with a body of trained labor and team work, will better insure economy in moving earth of whatever nature than any other factor in the whole problem of road construction.

WEDNESDAY MORNING, FEBRUARY 24.

9 O'CLOCK.

MR. PRATT: Sand-clay, topsoil and gravel, classified together, all represent one type of road, inasmuch as the materials of which they are constructed consist of grains of sand, coarse pebbles and the cementing or binding material is some form of clay. So, they are classified together as one type of road, and the discussion this morning will be given

to this type of road, its construction, composition, etc., and this afternoon the first hour will be given to the examination of these road materials.

The discussion this morning of the sand-clay, topsoil and gravel roads will be opened by a man who is probably as familiar with this type of road as any man in the country. You know this type of road is peculiar to the South. Gravel roads have been used a great deal in the North, but when we speak of the sand-clay or topsoil roads, they are peculiar at the present time to the Southern States. Professor C. M. Strahan, of the University of Georgia, will make us a talk and lead the discussion on the question of "Sand-clay, Topsoil and Gravel Roads." I am very glad to have him here with us and to introduce him to you.

Sand-Clay, Top-Soil, and Gravel Roads

BY C. M. STRAHAN,

Professor of Civil Engineering and Director of Good Roads Department of the University of Georgia.

If there is one thing which marks the community of interest of the Southern States more strongly than another, it is their common difficulties in solving the problem of adequate public roads. As a matter of fact, from the standpoint of importance and complexity, the road question is the largest common interest between all the states of this great country, and the quest for a large mileage of improved roads at low cost is the vital demand of every State and of every county that is awake to its future progress.

I have just come from the rich State of Michigan with its two hundred miles of \$15,000 concrete roads and its eight thousand miles of \$3,000 gravel roads, where they are earnestly asking what can be done with the seventy-five thousand miles of earth roads yet unimproved.

The problem is so large in every State that financially the first steps in road betterment must be limited to the low cost road; and it is difficult to see how a betterment expenditure above \$1,000 per mile can be widely available for many years to come for any considerable percentage of the 2,300,000 miles of public roads of the United States. The high priced road must remain the exception, and the low priced road the rule, in all extensive road programs.

Georgia and North Carolina have recognized this controlling fact, and have been working along very similar lines. The essence of their efforts has been to fully and completely utilize local materials in making the wearing surface of the road. Naturally and most largely, attention has been given to natural soils of sand-clay composition, to sub-surface beds of promising character discovered in grading, and to artificial mixtures of clay with sand, and of sand with clay according to the demands of the immediate soil on which the surface coat is to be built. We use the terms "top-soil roads," "semi-gravel roads," and "sand-clay roads," to describe the several types. By field experience and by laboratory examination of soils and mixtures used, we have come to know more about the behavior of these materials, and how to assure ourselves of adequate service in advance of construction. It is my privilege to go over with you the lines along which experience has led us, and to point out a proper conception as to how and why soils and mixtures of this class can be intelligently selected or compounded into efficient wearing coats.

Cost being the controlling factor, it is readily seen that natural soils and soil ingredients offer distinct economic advantages by virtue (1) of their abundance and cheapness, (2) of minimum haul, (3) of a physical state ready for easy loosening, transporting, mixing and shaping, and (4) by virtue of the minimum expense and maximum simplicity of the outfit for road building purposes. If we can add to these advantages the further qualities of prompt consolidation, of freedom from softening under wet weather, of reasonable smoothness with absence of deep mud or deep sand, and of good durability and ease of repair, we will thus have not only an inexpensive, but a highly desirable road surface.

While to many, the attainment of such results with soils and soil mixtures may seem pure idealism, there is abundant evidence in Virginia, in the Carolinas, in Georgia, and in Alabama that a close approach to this ideal can be and is being made, and that very substantial betterments are secured when intelligent methods of selection and of construction are applied to the soils and soil ingredients widely available in many localities and over large areas of our South Atlantic States.

Emphasis is to be laid on the search for suitable natural soils, on a clear conception of what constitutes a serviceable road soil, on the definite examination of the material in advance of use, and on the knowledge of making effective additions to inadequate soils of those ingredients which will make them adequate and efficient.

It will be profitable to discuss the composition of soils and the basis of judgment by which a soil may be pronounced suitable or unsuitable for road building. The laboratory side will be presented first; but it must be borne in mind that laboratory methods and deductions are valuable only as they have been related to the field history of the material under weather and traffic conditions. The road laboratory of the University of Georgia has examined perhaps a thousand samples of road soils and has kept track of the service rendered by many typical samples. Out of these records spring the data and the conclusions which are guiding us in our advice to the various counties in the State.

The chief ingredients of natural soils are clay, sand and gravel, silt, mica, feldspar, lime, iron salts, and organic matter.

The value of a soil for road building is a function of the amounts, of the several ingredients, of the sizes of the particles, and of the qualities which they possess. The presence of mica in any considerable amount is always undesirable. A large per cent of lime is probably a source of weakness, on account of the softness and easy grinding of the material. The laboratory experience on this point is not large, as most of the soils examined by us have very little lime. Small amounts of lime are probably useful as a binder. Iron salts, when present, are distinctly valuable as a cementing agent, but the majority of soils carry only small quantities. Organic matter in small quantity and in a finely divided state aids also in binding the soil, but it rapidly decays and its effect is lost. In large amounts, organic matter renders the soil too soft for road purposes. Much feldspar is objectionable on account of its friability and its rapid grinding down and weathering into slippery clay. It thus appears that in general the chief dependance for service must rest upon the clay, the silt, and the sand and gravel content. The laboratory seeks to separate these ingredients and examine their char-

acter. The separation is a physical one based on the diameters of the particles.

By passing 500 grams of the dried soil sample through a No. 10 sieve, we determine the coarse residue left in the sieve, and classify it as *gravel*. The portion passing through the sieve constitutes the main sample for further percentage analysis. Various soils are thus brought to a definite standard of maximum size for comparative study. Fifty grams is taken and vigorously shaken with 200 cc. of water in a wide-mouthed bottle. It is allowed to settle for eleven minutes. The turbid water is siphoned off to a depth of eight centimeters. The operation is repeated until a clear effluent is obtained. The addition of 5 cc. of dilute ammonia hastens the washing. The exact figures given are derived from microscopic tests of the suspended sediment whose maximum diameter under these conditions will not exceed .01 millimeter. Particles of that diameter and smaller we believe to be chiefly clay. There may be also small quantities of lime and organic matter, but we are justified, after evaporating the washings to dryness, in classifying the material as clay. A further separation of the clay content may be made by digesting with water, settling for twenty-four hours and siphoning off the extremely fine sediment. Repeating this many times and evaporating the wash water we secure what may be called the "colloidal clay." The point of this tedious process is to establish the probable fact that the adhesive value of different clays largely resides in this colloidal portion, and that highly colloidal clays are needed in less amounts than less colloidal clays when we are making or selecting road soils. Moreover, the tests indicate that the shrinkage and expansion of clays is largely a function of the very fine or colloidal part; and as this expansion of the clay under rain and frost has an important bearing on the integrity of the roadbed, it is worth while to know about this colloidal clay in forming a judgment of a given soil sample. Fortunately, we do not have to make the actual separation for an ordinary sample, as we may be guided by simpler tests of stickiness and plasticity.

Turning now to the solid residue from which the clay has been washed out, it is filtered and dried, and passed through a nest of standard sieves. Nos. 20, 60, 100, and 200 are the four sizes which we have found desirable. The residues caught on the four sieves together make up what we call the *total sand*. To the very fine particles which pass through the No. 200 sieve we give the name silt. The silt is itself largely sand, but of very low diameters, .07 to .01 mm.

Examination and study of these residues and their behavior in the presence of water lead to the following conclusion: The silt aids in making a dense mass by filling voids in the coarse sand. It has no adhesive quality. When moist it has some supporting power, but when saturated it assumes the character of quicksand. No. 200 residue likewise aids in forming a dense graded mixture. It has good supporting power when moist, but loses most of it when fully saturated. No. 100 residue shows real interlocking strength when moist, and even when saturated. No. 60 and No. 20 residues show marked interlocking strength, increased, if anything, by the presence of water and not weakened appreciably by saturation.

We may now formulate a conception of the joint action of these ingredients in forming a satisfactory road soil.

First. Broadly speaking, the sand and silt and clay should form a closely graded mixture capable of packing into a dense mass with a low per cent of voids. Some of our best roads show voids of only 20 per cent, as con-

trasted with normal sand voids of 35 per cent to 50 per cent; and an actual weight of 130 pounds per cubic foot, as contrasted with ordinary earth at 110 pounds, and with concrete at 150 pounds per cubic foot. The density is at once an evidence of strength to resist traffic wear, and of ability to resist water penetration.

Second. The clay present performs the function of a weak cement which in dry weather binds together the sand particles and maintains a smooth surface. Unfortunately, in wet weather, the clay tends both to soften and to expand, and if too much is present, the traffic will churn its way down from layer to layer, and the road becomes muddy and unserviceable. Thus in wet weather, the strength of the road soil is directly dependent on the interlocking strength of the sand content, and upon the absence of excess clay which by its expansion would lift the sand grains apart, and lubricate their movement. It becomes clear that coarse sands will give better results than fine sands; in wet weather, by virtue of their greater interlocking strength; in dry weather, by virtue of their hardness and resistance to traffic wear.

Third. If a properly balanced soil bed has fortunately been secured, we may explain its resistance to weather and to traffic as follows: It derives hardness and body from the large amount of sand present, chiefly the coarse sizes, both in wet and dry weather. In dry weather, it is held to smooth surface by the right amount of clay cement, aided by iron salts and, perhaps, by small amounts of lime. In wet weather, its density and low porosity tend to exclude rapid penetration by water. The surface layer does soften and some moisture soaks downward, but the clay binder it encounters will expand and tend to seal up the capillary tubes and pores leading down into the layers below, which thus remain fairly dry and amply strong to support the traffic. If, however, the clay is in excess, or too highly colloidal, the expansion, which takes place, breaks the interlocking sand grains apart, and the weight and impact of the traffic seriously disturbs the surface and works it into mud. If, on the other hand, too little clay is present, or a clay with very slight adhesive value, the road will suffer in dry weather from dust and loose sand created by the traffic wear.

It thus appears that there exists in the use of soils and soil mixtures a limiting zone outside of which, in either direction, proper service is not secured; and within which, according to exactness or non-exactness of the composition, varying degrees of service will result. The field histories are very instructive on this point. There are soil roads of great durability, of excellent surface, of a hardness in all weathers that will carry the heaviest rural traffic. And there are others, grading down to a service just short of deep mud in wet weather or deep sand in dry weather, workable by light road drags, and calling for frequent resurfacing after rains.

The studies already made do not enable us to define with absolute exactness the limits of this effective zone, but the indications are well nigh conclusive that the range of adequate soils lies between 60 per cent and 80 per cent of total sand, and between 12 per cent. and 25 per cent of clay. Within those limits, the quality of the clay and the relative per cents of the several sand sizes and the absence of large amounts of silt are important factors in judging of the service which will be given. Much confidence may be felt in a soil or artificial mixture which carries from 30 to 40 per cent of sand above No. 60. When most of the sand lies below No. 60, a hard surface cannot be expected, although good service may be obtained if repairs are promptly made.

When the amount of total sand is low, the clay and silt percentages are,

of course, larger and conversely. The coarser grades of sand and also the gravel present directly influence the hardness and wearing value of the mixture. The finer sands, and relatively large amounts of silt and clay, lead to softer surfaces. Within the suggested limits of composition, the resulting roads may be classed as hard, medium, and soft; but even those classed as soft are free from deep mud in wet weather, or deep loose sand in dry weather, and represent a degree of service and betterment which justifies the \$300 to \$600 per mile cost. A material in which the total amount of clay and silt exceeds 45 per cent. is to be looked on as inadequate. One with less than 10 per cent clay, except in the case of true gravels, will be deficient in binding value. It is to be noted that the highly colloidal or sticky clays should not exceed 15 per cent, while the less colloidal clays may sometimes run as high as 28 per cent.

The subjoined table of analyses of roads in various parts of Georgia, all of which have given good service, and many of them exceptionally durable, will throw some light on the manner of reporting road soil analyses. The best samples are marked with stars, the medium ones with daggers, and the softer sand-clay roads with the letter s.

The following table of mechanical analyses has been made by Adjunct Professor S. B. Slack by the new and more complete methods adopted by the laboratory since 1913:

TYPICAL GEORGIA ROAD SOILS.

Analysis After Separation from Gravel.

COUNTY	Diameters in Millimeters							
	Gravel	Sand					Silt	Clay
	Above 1.85	1.85-.86	.86-.24	.24-.14	.14-.07	Total	.07-.01	.01-.00
North Georgia								
476 Cobb.....*	4.0	8.0	33.0	17.6	13.6	71.2	15.0	14.0
466 McDuffie.....*	13.0	19.6	44.6	8.0	6.0	78.2	4.5	15.0
150 Clarke.....*	3.0	8.5	36.0	12.5	11.3	68.3	16.2	15.0
10 Clarke.....†	-----	7.8	34.3	9.2	9.0	60.3	12.8	25.0
Middle Georgia								
108 Dougherty.....†	0.8	0.8	30.1	15.4	20.0	66.3	14.1	18.0
124 Sumter.....†	-----	8.0	22.0	14.7	15.3	56.6	14.6	27.5
424 Muscogee.....s	-----	2.8	8.3	18.4	25.0	54.5	12.4	31.0
120 Bulloch.....s	10.4	4.6	22.0	14.7	15.3	56.6	14.6	27.5
106 Bulloch.....†	10.0	4.0	30.0	18.5	12.1	64.6	13.6	20.0
South Georgia								
434 Emanuel.....s	-----	2.4	9.2	19.7	27.0	58.3	12.8	25.0
103 Brooks.....†	-----	2.7	20.7	21.2	26.4	71.0	14.8	14.2
113 Mitchell.....*	-----	2.0	32.0	20.8	17.4	72.2	13.4	14.0
Special								
470 Augusta Gravel...g	15.2	28.0	54.4	6.0	2.2	90.6	3.4	6.7
116 Pipe Clay.....w	-----	14.3	16.9	4.8	4.7	40.7	8.8	50.0
Sieve numbers.....	10	20	60	100	200	-----	-----	-----

NOTE—* Hard and very durable. Few repairs.

† Medium and good service. Moderate repairs.

s Soft. Must be frequently reshaped. Repairs \$25 to \$50 per mile annually.

g True gravel—excellent quality.

w Worthless.

The following road histories attach to the respective samples. The laboratory proposes to visit again these roads and others built later under its advice to supplement and extend the data regarding field efficiency and repair costs, preparatory to a complete bulletin of the laboratory's investigations:

Sample No. 476. Atlanta-Marietta Road, Cobb County. Taken in 1914 from roadbed. Topsoil. Very hard and smooth. Not cutting. Heavy traffic. Age one year.

Sample No. 466. Thompson-Augusta Road, McDuffie County. Taken from roadbed, 1913. Topsoil. Very hard and smooth. No mud. Heavy auto traffic. Age one year (?).

Sample No. 150. Athens-Danielsville Road, Clarke County. Taken from roadbed in 1912. Topsoil. Very hard and smooth.

Now as to the gravel. Comparatively few natural soils contain large amounts of gravel, and yet we have encountered in our Georgia experience a number of soils which may be fairly called semi-gravel soils. They have made most excellent roads where the coarse particles were of hard siliceous material. In these cases, we may think of the soil below No. 10 sieve as an earth mortar, and of the gravel itself as corresponding to the broken stone in concrete. How much of the gravel will this mortar carry? The answer is, any amount; for the gravel rapidly adds supporting power, hardness, and interlocking strength to the whole mass, and if it becomes large in amount, it passes into the true gravel road with the soil filling the voids. But gravel exceeding two or three inches in diameter is objectionable, and unless the gravel is graded in size, it may be a source of trouble. I have just seen in Orange County (Virginia) a soil which carried about twenty per cent. of a rounded gravel of virtually uniform size on top of a soft soil having only a small amount of sand. The lack of grading in this soil and gravel mixture deprives it of interlocking strength, and its use was a virtual failure.

The hardness and quality of the gravel is to be carefully watched. Frequently it is composed of feldspar, or of micaceous masses, or of indurated clay. These are all too soft, and break down under traffic into undesirable elements. Nothing is worse than mica in destroying the efficiency of an otherwise good road soil. Some soils have been examined containing two to three per cent mica that have given excellent service, but any larger per cent is highly undesirable. Feldspathic gravel is likewise undesirable as it rapidly grinds down under traffic into a slippery clay-like material. Indurated clay nodules are, of course, worthless.

During field inspection, the gravel residues where water has been running give a useful indication of the quality of the soil itself, by showing the kind of rock masses from which it was derived.

I have dwelt upon the laboratory side of road soils, because it is time to recognize some standard of examination from which to accept or reject a given soil material for road surfacing. The proposition has seemed so simple, to harden a clay road with sand, and to bind a sandy road with clay, that many very crude mixtures have been made and many poor natural soils have been selected to the great disappointment of both the taxpayer and the road builder. Bad errors of this sort can be avoided in advance of construction by submitting the proposed soils to examination by a competent road laboratory. The need of such laboratories in our Southern States for the study of this class of road materials is a pressing one and their work can do much to perfect the methods and the results. But such laboratories must work in close touch

with the men who are actually building the roads, and must derive their laboratory conclusions from a close study of the road history of the samples examined.

Much of the success of building soil roads depends upon the man in charge of field construction. His thoughts should dwell upon and his methods reflect the following important aims:

First. To secure a natural soil, or to make an artificial mixture of the *right* composition. The laboratory must aid him in this.

Second. To bring about a thoroughly uniform mixture before consolidation is attempted.

Third. To deposit in one thick layer an ample quantity of the material.

Fourth. To see that it is packed from the bottom upwards.

Fifth. To watch it carefully during packing, and constantly to use the road machine in maintaining the proper shape and crown.

Nothing can take the place of the first item. The search must be made for a natural top soil of adequate composition, or the local soil must be examined and its deficiencies made good with sand or clay as the case may require. In many parts of North Georgia, excellent topsoils are found in detached areas on hilltops and ridges, not far from the road. Often a topsoil which is too sandy is corrected by plowing into the clay subsoil, and mixing by harrows or in loading. Sometimes, when the nearby soil is slightly deficient in sand, sand from a branch or creek is hauled and mixed in. In middle Georgia a substratum of natural sand-clay found within a short depth from the surface is widely distributed and is of good composition. It is excavated and used. The sand in this material, while sufficient in quantity, is rather fine in size. The roads are good, but of medium hardness and need frequent dragging. In South Georgia, overlaid with sand, the search is for clay outcrops, and for substrata carrying clay. Artificial mixtures of sand and clay are made; thorough mixing by plows and disc harrows follows; and then consolidation by the action of the traffic. In all parts of the State local methods vary with the materials to be found. I have no doubt that North Carolina has been following similar methods of search and use. But all of us have given too little attention to assuring ourselves in advance that our mixtures were of adequate composition. To illustrate, the second item, Muscogee County, in charge of Mr. J. R. Lane, Columbus, Georgia, is a striking example of the value which attaches to thorough mixing of these soil ingredients before consolidation. It would pay any road engineer in a sandy section to visit and inspect the work and methods in Muscogee County.

As to the third item, anyone who once has tried to deposit this type of material and allow it to pack in successive thin layers will know already the importance of not doing it again. A solid deep bed deposited in one layer not less than ten inches thick, and consolidated as one mass, is a most vital requirement of this work. Our clay binder is weak at best; it softens on the surface in rains, and we should not risk the breaking through of the traffic into the subsoil below. Greater thickness than ten inches should be used when the foundation is of weak micaceous or silty soil, and where it is subject to softening or saturation from below.

The fourth requirement of packing the bed from the bottom upwards is commonly attained by reliance on the hoofs and wheels of the construction teams and the traffic. It is surprising what density and even uniformity of consolidation follows this simple process. The ordinary roller is worthless.

It forms a crust which breaks through in wet weather. But if some type of roller with multiple narrow tire rims could be devised, a soil road consolidated in this way would repay the extra cost. The sheep foot, or petrolithic, roller is on the market and has been used successfully in California. Its price is

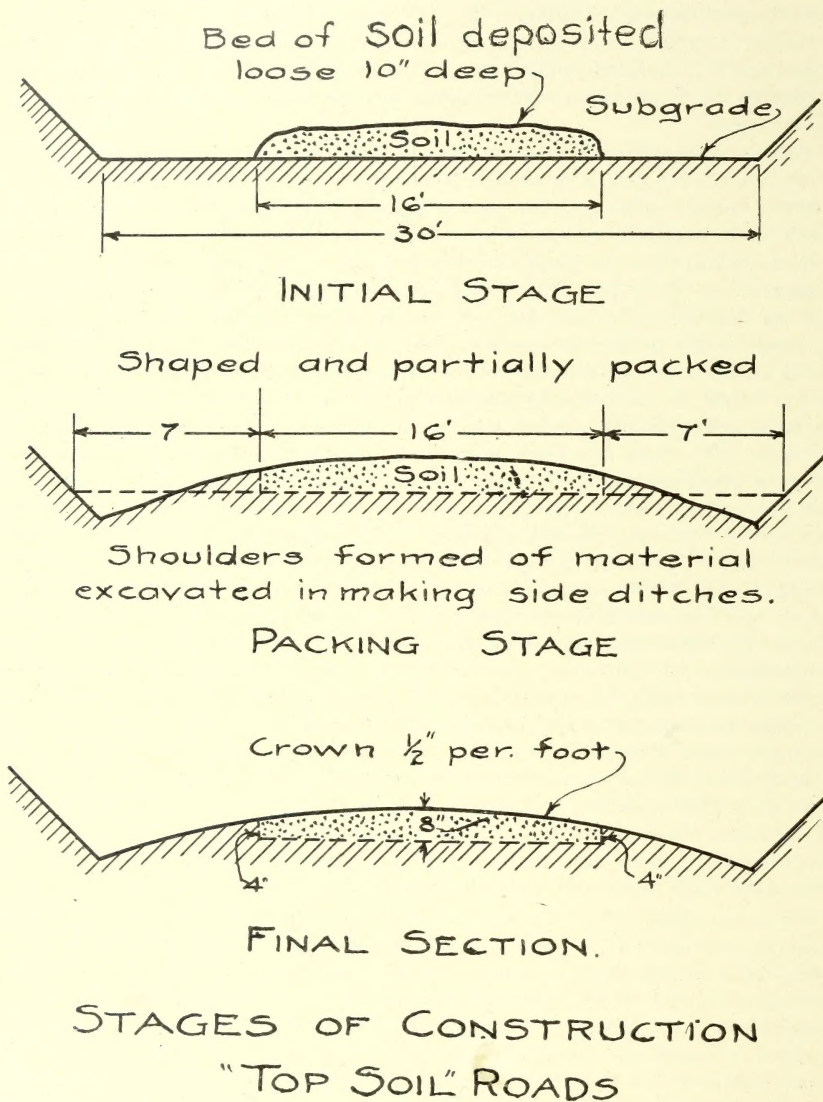


FIG 7

high and it requires much power to operate it. I have not heard of its use in any of our Southern States. During consolidation it is a blessing in disguise to have a spell of bad weather on a freshly laid soil road. The tem-

porary puddling and deep mud mean denser packing as the road dries off and a more durable road.

The process of consolidation by the traffic occupies several weeks or months according to the weather, and during this time it is extremely desirable that the surface be promptly reshaped after rains in order to avoid lumps and to ultimately attain a smooth, evenly crowned surface.

What may be called the approximate standard section in our Georgia roads is shown in the accompanying figures, and also the steps through which the road goes in construction and consolidation. Fig. 7.

The past winter, with its unusually protracted rains, has seriously tested the merits of every improved soil road in the South. Many reports have come in of failures and partial failures. But along with these other reports have come of surprising service from roads built with due regard to the principles I have just presented. There is nothing to warrant abandonment of the soil road; there is much to stimulate us in perfecting its merits by avoiding our obvious mistakes.

The first of these mistakes has been in lack of care in the selection of the soils used. It is easy to be satisfied with a soil very close by the road, or one which the landowner will donate free of cost, without taking steps to assure ourselves that it is a really suitable soil. This is none the less a mistake, which a long wet winter invariably will reveal. A road soil which is not really a road soil of the proper composition will not make a durable road.

The second mistake is that in our hurry to build many miles which the public so greatly need, we have not used an adequate thickness of the material. We have laid thin beds four and five inches thick and have demanded unreasonable service from them. It is like making a child carry two bushels of corn to mill on his shoulder. I have been surprised at the manful effort which many of these thin roads have made, lasting through several ordinary winters, and yielding only under the severest stress of weather and traffic. Nor is everything lost when such a road breaks through and cuts to pieces. A new layer of good soil of the same thickness as the original one will be stronger by virtue of the improved foundation. If the softened road be lightly plowed in wet weather and a six or eight inch layer of good soil be spread on it, the new consolidated bed will most probably be entirely strong and adequate, unless the subsoil was very micaceous and silty.

The third mistake has been that in our repairs of these roads we have allowed ditch scrapings, or poor soils from the sides, to be spread back over the good material to its rapid injury and ultimate destruction. Far better to leave the road surface untouched for a long period of time than to destroy it by semi-annual layers of soft material spread over it in the name of repairs. The contents of the side ditches should be shoveled or hauled entirely away from the road.

A fourth and very serious mistake, one that contributes to careless repairs, is the impression that a road once built is going to last forever, and therefore no thought need be taken to have on hand the proper soil materials for repairs and needed reconstruction. The readiest excuse in the mouth of the foreman is that he had nothing except what he finds in the ditches or on the banks with which to make repairs. If the soil road is to be looked on as a permanent thing in our road policies, and not simply a temporary makeshift, road officials must recognize the absolute necessity of purchasing, or securing by gift, adequate supplies of these materials in advance, at reasonable inter-

vals along each improved road. The well-built road of this type may be counted on for a life of ten to fifteen years or possibly longer; but this outcome requires systematic maintenance with materials equally as good as those which compose the original bed.

That the repairs of such roads are easily made and small in annual cost, is one of their most fortunate advantages, but a failure to make the repairs systematically and with proper material means rapid deterioration, reduced life and distinct loss of both money and traffic service.

DISCUSSION.

MR. MARTIN.—I would like to ask which part do you put down first, clay or sand?

MR. STRAHAN.—Usually in sandy sections it happens that the original bed is sand; so the first thing to put in artificially will be clay; but in some cases you do grade down through the hills of middle and southern Georgia and you are on a clay mass. Therefore, it depends upon the local quality of the material, whether it is sand or clay. You either just simply bring in a natural mixture or make alternate layers of sand and clay. In a section like this where you have such a superabundance of clay, I think I would put my layers in such a way that the sand layer would come last, on top; but this would depend upon how many layers I had to make. In using the layer system, you must be sure to mix thoroughly and not leave the sand and clay in stratification. It would go to pieces, one layer after another. That is why I emphasize putting this bed in as a solid ten-inch bed and letting it pack together from the bottom up.

MR. FALLIS.—Please tell us why you use a thirty-foot instead of a narrow road. A great many of our counties want to use a narrow road. Please explain.

MR. STRAHAN.—That is our standard first-class road. There are narrower roads in Georgia than that. I think there are a great many merits in view of our traffic needs and water conditions that seem to call for the thirty-foot road. First of all, it is hard to understand how you can get along without the two track space for your automobile traffic. In Michigan they say they build a gravel road nine feet wide with deep ditches on each side. That is a right good tribute to their topsoil, because if it was anything like our clay, we would soon get into a great deal of trouble. But I cannot quite see the nine-foot road unless it is supplemented with something good on each side. What is the minimum you must have for those two tracks? That is clear if you are going fast * * * I prefer and want a flat, shallow side ditch in preference to a deep one. I think deep ditches are dangerous. The Michigan plan is a nine-foot road with these deep ditches on each side, and if a scary team and an automobile meet, I do not know what happens. Providence must take care of them like it does in the mountainous counties. I prefer the shallow ditch. A shallow ditch will resist erosion and breaking down so much better than a deep ditch. In most of Georgia we seldom have anything less than twenty-four feet wide—some may be twenty—but our standard road is thirty feet.

In cleaning out the side ditches the material was naturally scraped towards the surface. In November or October during good, dry weather, that work was done and this mass was left here. In December in Georgia there came this heavy rain. It soaked as much as it could but particularly right in this

deposit—four or five inches of this bad material into this material below. Traffic came along on it and would cut in deeper here than over here in the topsoil. Finally the stress was so great as to actually break through the mass. It was simply a warning against making deposits of old, washed material on a bed of the good sand-clay mixture. You can take a cubic yard of poor soil and injure 25 to 30 square yards of surface of good road.

MR. STACY.—I want to emphasize one thing from another point of view, and that is to guard against the matter of haste in the making of these roads. Not only does it make a poor road, but it makes a much more expensive road in my judgment. Somebody in the last analysis must pay even for the cheap sand-clay road, either through a bond issue or direct tax on the people. I have had this experience that bears right on this line and corroborates what Professor Strahan has very forcefully presented to us, and what we learn by experience we are pretty apt to remember.

Where the road has been hastily built the bills for surfacing material have been exceedingly high. Where there has been some question about meeting a certain road or where there has been a choice between two different roads, if the engineer working with a commission will go and select his material, will keep in mind where he can get this material or where it can be obtained, if he can go slowly, then he will save hundreds and thousand of dollars to the taxpayers in the ultimate cost of the road in surfacing materials. In addition to that he will get a far better road because of that.

MR. PRATT.—One point I want to bring out—the thing of a thorough mixture of the materials—if you are going to add them separately to the road. If you are going to start with a clay base and add sand to that, or if you have a suitable sand and add clay to that; in both it is absolutely necessary to have thorough mixing. I have a good illustration of this in Henderson County. About eight or nine months ago they wanted to make some sand-clay roads in Henderson County. They had a pretty good quality of clay subsoil and all that they expected to do was to add the right proportion of sand to that clay. They wanted to know how to do it. We sent up a general specification for making a sand-clay road. The supervisor wrote back that they could not do it that way. They wanted to know what would be the results to put the sand on the road and leave it to the traffic to do the mixing. I wrote him that he could in the end get a pretty good road that way, but it might take from eight to eighteen months before you get a thorough mixing. They had no chance to get that sand-clay mixed this past winter and these roads have been almost impassable. They have a thorough mixture now, I think, of the sand-clay. I do believe, however, that when that road gets ironed out and dragged into shape it will be a hard road, but not as good as it would if they had made that thorough mixing at the beginning and then dragged it out and brought it into shape. In the end it has cost the people just as much as if they had gone ahead and made the road right in the beginning. The other point to emphasize—where you have to put the material on in layers, a layer of clay and a layer of sand—is the need of more thorough mixing before these mixtures get packed, because if you do not, the water will get down and soften it and you are going to get a mean, muddy, soft road during the rain.

Question.—In speaking of sand on top of clay, about what per cent of sand washed away before it got mixed by traffic?

MR. PRATT.—There was not a very large per cent, but a certain amount of

sand went down into the ditches. One other thing to mention in regard to ditches. I may be too much of a crank on the question of material you find in ditches. I have tried to get the men to take a definite stand that no material that is down in the ditches—not on the shoulder, but down in the ditches—shall ever be brought onto the surface of a road because there is always going to be a certain amount of mulch or vegetable matter in that material. No matter how nice it looks, that material should never be brought back upon any part or portion of the road and particularly that portion that represents the surfaced part of the road. In order that there may never be any chance of bringing that on the surface, I have tried to make it a cast-iron rule that the stuff in the ditch shall be thrown on the opposite side from the road. If that material is piled on the edge of the ditch, rains come and it is washed back into the ditch. Throw it on the opposite side from the road. Keep it away from the road.

MR. SPOON.—I have had more field than laboratory experience, but it furnishes us the basis for our knowledge, and it likewise gives us some vital suggestions in regard to actual construction. There are a good many young men I see before me today who expect to make road work their calling. To them I want to say this, that in the successful building of a sand-clay or topsoil road, eternal vigilance is necessary. You have got to be on the job. You have got to watch constantly, because you cannot take every shovelful to the laboratory and analyze it; you have got to use common, plain, practical judgment and close care in making selections of materials, and, above all things, you have got to be careful to select the foreman who does this work. He must be a man faithful, good and true to your instructions.

I want to emphasize this: Remember never to put new material on the road in the fall of the year. Clean out the ditches and throw the material out on the banks in the fall of the year, but leave your roadbed smooth and hard and do not add anything to it. In the spring add necessary materials which will add strength and become part of it. By going over and studying the road conditions throughout a county, you will learn by observation the things necessary to be known, and some of these little things are the crucial things. The things you will observe by going through any country or community where roads exist naturally will point out to you suggestions and ideas valuable in road building.

MR. PEYTON.—One question in reference to the disposing of the material in ditches. I have a good deal of heavy side-hill work and have trouble in the disposal of the material. I have several cuts which are really too deep to dispose of the erosion material in the ditches; some of them 500 or 600 feet long in the cuts. I would like to have some one give me an economical solution of how to dispose of that material; whether to take it up with scrapes to the grade point or to any point in the cut, say the shoulder where it could be disposed of in the construction of the road, or had those ditches better be left deep enough to take care of the road?

Answer.—The only way I see to get around that is to put the hip or drag scrape into those ditches and carry that material to the grade point and dump it off on the fill and then round up your road with road machine or drag.

MR. PRATT.—Have you got the ditches out of the cut so you can carry the water from the mountain side so none can come down from this slope over the road? Of course you may find it necessary to increase the slope. You will find some will stand up very steep and other places require much more

slope in order to get the material to stand up. I believe it is almost impossible for a man to be able to account for a great many of the slides we have in the actual construction. You will, in your mountain work for perhaps two years after the road is constructed, find that you will have to contend with these slides due undoubtedly to geological conditions affecting the decomposed rocks. Finally you get a stability of the side cuts and you will not have much trouble with it.

Sand-Clay and Topsoil Roads in Craven and Wayne Counties

By R. E. SNOWDEN, Road Engineer.

There is such a wide difference in local conditions, soils and the requirements, between these two counties, separated as they are by only one county of about fifteen miles in width and lying along and drained by the same river, the Neuse, that to properly treat the subject of sand-clay and topsoil roads in the two counties it will be necessary to divide and describe the two under two separate and distinct heads.

First, we will take Craven County. This lies within twenty-five miles of the ocean and is divided into three sections by the Neuse and Trent rivers. The land lies so flat, after it rises above the streams and marshes, that while there are very few engineering difficulties, thorough drainage is very difficult and expensive. There is no soil found in the county that will make a surfacing material that will hold up under heavy traffic.

The rivers are bordered by low swamps, that are subject to overflow for a distance of from one-quarter of a mile to two miles. All the streams in the county are tributary to the Neuse River, which is subject to a storm tide of ten feet above the average stage. Back of these swamps are belts of beach or river sand, that drifts to a small extent under heavy winds. This is usually underlain with marl or coquina rock, often so deep as to make it impractical to strip off the overburden. Behind these belts of sand lie the stiff or clayey soils, the savannahs and pocosons. The savannahs occupy about one-half the land area of the county. They consist of very level land lying about ten to fifty feet above tide, composed of gray, sandy soil, underlain with silty clay, covered with longleaf pine, native grass and sometimes very scant growth of underbrush. Some of the savannahs have been drained and are in cultivation. The pocosons are shallow, elevated basins, almost perfectly level, covered with a dense growth of bushes, briars, reeds and vines, with a very scant growth of pines of very inferior quality. The soil is black, peaty muck, varying in depth from a few inches to seventeen feet, which burns readily when dry. This is underlain with clay and sand or pure sand, generally, but is sometimes underlain with a kind of black clay known locally as "bay soil." Around the pocosons, on the side towards which the water would naturally flow, there is usually a slight ridge that helps to retain the water. The pocosons occupy about one quarter of the area of the land in the county.

New Bern, the trading point of Craven and several of the adjoining counties, is located at the junction of the Neuse and Trent rivers. The soil in the town and that for four miles out of town is a fine river sand and sandy loam and silt (Norfolk fine sand and Norfolk sandy loam). Much of the commerce moves both to and from New Bern by water, but there is enough by road to make the traffic very heavy on the four roads leading out of town. There have been built within four miles of New Bern seven pieces of sand-clay road, all of which have been failures. The first two were built by high-

way engineers, as experimental roads, the money being supplied by local subscription, and the engineers by the Office of Public Roads. The next three were built by inexperienced foremen. The last two were built by the writer to convince the local authorities that successful sand-clay roads could not be built out of the material available in the county. All were of the clay on sand base type and failed rapidly under heavy traffic, except one the writer built on the sand ridges on the east side of the Trent river, and in that case the sand fill under the clay blew away before a Bermuda sod could get started and before traffic could break down the road. The instances of failure that came under the writer's observation, and he feels sure the others were from the same cause, were due to the sand being too fine and water worn and the clay containing too high a per cent of silt. The best material that could be obtained was used in the first and last two instances; had the average material of the county been used in these sand-clay roads, the failure would have been much more rapid and complete.

The rapidity of the failure of some of the early experiments may have been due in part to the lack of proper maintenance, but this was not the cause of the latter failures. During the past year that part of the Central highway that lies in Craven County's part of the Newport pocoson has been drained and shaped out of the black peaty muck and surfaced to a width of twenty feet, with twelve inches of topsoil, known locally as savannah soil. This material was taken from the savannah just west of the pocoson, hauled in and spread to proper depth, and smoothed with a light road machine, without mixing, and held to proper shape and smoothness with a road drag. This soil is gray in color, contains much sand and some silt with considerable clay. This work was suspended last November as it was all complete except fire-proofing the roadbed against the fires during the summer droughts. During the heavy rains and long cloudy weather in December and January this road has stood up exceedingly well, there being no time in these two months that an automobile could not be driven from the beginning of the pocoson to the Carteret County line at a speed of twenty miles per hour, with safety and comfort. All that is needed to make this road good three hundred and sixty-five days in the year is a little maintenance now and then, as needed.

It has been the writer's experience and observation that wherever the roads have been built of, or surfaced with this savannah soil they have withstood fairly heavy traffic, much better than the sand-clay that could be built out of such material as we have at hand in Craven County, and for that reason he has recommended that all roads carrying heavy traffic be surfaced with coquina rock, known locally as shell-rock.

Wayne County is about ninety miles from the ocean, is gently rolling and lies just above the Coastal Plain. There is very little swamp land in the county and all the other lands are gently rolling and easily drained. The county is divided by the Neuse and Little rivers. All watersheds in the county are tributary to the Neuse River. Most of the lands are in cultivation. The soil is generally gravel, sand, clay and combinations of sand and gravel and clay. Most of the sandy soils are underlain with clay. There is a plentiful supply of well distributed material throughout the entire county, suitable for excellent gravel, sand-clay and topsoil surfaced roads, especially sand-clay and small gravel roads. There are found frequent deposits of coarse, sharp sand and rich clay occurring together in the right proportions, free from detrimental soils of any nature. Along the beds of the two rivers are found

frequent beds of river gravel, grading in size up to one inch, usually mixed with small gravel and clean, sharp sand. Along the sides and valleys of the rivers and in the old beds of the streams are found frequent beds of the same material. Deposits of excellent sand are found at the heads of the ravines and on the slopes of the hills just above the streams. Good rich clay very low in silt is found below the tops of the hills on the slopes, usually on the eastern slope, in the stream banks and in the old beds of the streams. The swamps are generally long and narrow; the streams not subject to sudden overflow.

Wayne County has for a number of years tried to build sand-clay roads, but they have been more or less a failure, due to the lack of intelligent direction of the forces. The soil had been poorly selected, and proper care was not exercised in the mixing, in fact very little or no mixing was done; especially was this true of wet mixing. There was some sand-clay road that in places was all right, but there was not that uniformity of durability in the roads that a well proportioned and well mixed surfacing material usually possesses.

Goldsboro Township issued bonds in 1913 for the construction of good roads in that township. In the spring of 1914 the writer was engaged by the township road trustees to do the engineering for their roads, and under their supervision was built the Stantonsburg road and the Pikeville road. The roads were relocated by him on a maximum grade of three per cent and a maximum curve of ten degrees, and designed and built with a width of thirty feet with a surfaced width of twenty feet, having a crown slope of 1:20. Small waterways of double strength vitrified shale pipe with concrete headwalls. Intermediate sizes of reinforced concrete culverts and all large sizes of the "I" beam type of reinforced concrete bridge, having all beams thoroughly encased in concrete, the floor system of concrete reinforced with expanded metal between beams, carrying twelve inches of surfacing material across the bridge, in that way leaving no break in the roadway or surfacing material; all designed and built with a safety factor of five to carry a load of twenty tons.

The road was graded true to grade and the deep sandy places left flat; the clayey places shaped true to crown. On the sandy foundation there was placed three inches of good rich clay, spread over a width of twenty feet. This was then plowed, beginning at the sides and turning out until the entire road was plowed. Next there was placed on the road a double roll disk harrow of ten disks to the roll and the road was harrowed until the material was thoroughly pulverized, when it was again harrowed, beginning at the middle of the road and turning the material in until the entire road was plowed, care being taken in each instance not to take too much width at each furrow. The road was then harrowed with the same disk harrow as before until the material was thoroughly pulverized. The next step was to shape up the road with a road machine and allow it to rest until the first good soaking rain, when it was thoroughly puddled with a tooth harrow until it was a complete slop, then allowed to dry out; and while drying the road drag was used to keep it in shape until it was thoroughly dry, and true to shape. Over this there was then hauled and spread three inches of the best sharp, coarse, gravelly sand, and allowed to lie until the first rain, when this was cut in with a disk harrow and thoroughly puddled as before. The clayed places were plowed to a depth of three inches, beginning on the edge and turning the furrow out, thoroughly disked, and over a width of twenty feet was placed

four to six inches of good sand, sharp and coarse, thoroughly disked in and again plowed, beginning at the middle and turning the furrow in toward the middle of the road, again thoroughly disked until all the material was completely pulverized, shaped true to section and allowed to rest until the first soaking rain, when it was thoroughly puddled and then handled as clay on sand, as described above.

Goldsboro is the center of trade for Wayne County and much of the surrounding territory. As these roads begin at the edge of Goldsboro and lead to the township line, supplying a well developed agricultural section beyond, the traffic, both on rubber and steel tires is very heavy. During the recent heavy rains in December and January these roads have held up almost perfectly in spite of the heavy traffic coming upon them, much being on heavily loaded wagons with narrow tires.

Observation and experience lead to the inevitable conclusion that with the material at hand, such as Wayne County is fortunate to possess, all that is needed is care and skill in selection, proportion and mixing to get sand-clay roads that will be second to no other type of road.

Sand-Clay and Topsoil Roads in Orange County

By R. T. BROWN, Road Engineer.

If, during the past two and one-half months, the general public of Orange County had been asked for its judgment on the serviceability of sand-clay and topsoil construction for this section of the country the answer would have been very discouraging. The large amount of comparatively new work, the present limited system of maintenance, and the unusually severe weather conditions during this period have combined to make it appear that we needed a "365 Day Road Club." But with the return of clear weather and a few windy days the roads, with a few exceptions, are showing up better than many people thought. However, we understand by an improved road one which is better than the old road, not only in width and grades, but also in the condition of its surface in all kinds of weather. Hence the question regarding the roads of this county is: "To what extent have they exhibited the qualities of improved roads?"

As regards the kind of surfacing material used, there are four general classes of surfaces on the recently built roads in the county.

The first, used on only one short stretch of road, is artificial sand-clay. It was constructed by hauling river sand and fine gravel and spreading on a clay surface, then mixing by means of a disk harrow and shaping with a wooden drag.

The second class of material is a natural sand-clay mixture, obtained in a few cuts and pits. It is the remains of a decayed granite and has not had the weathering and the intermingling of vegetable matter that are brought by cultivation.

The third class, and by far the most extensively used here, is the topsoil surface. This is of practically all grades of topsoil in which there is any appreciable amount of sand and gravel.

The fourth class consists of a natural bank gravel, containing about the proper amounts of sand and clay or loam to bind it well. It is this material that is used on the Durham road from a point just east of the flat bridge for some distance toward the county line.

I will discuss briefly the qualities of each as a surfacing material, as shown by the results attained in this county.

The artificial sand-clay road was constructed in a rather random fashion, the hauling being done by local teams when they were not otherwise employed. Some of the sand and gravel was allowed to remain in piles in the center of the road for two or three weeks, until a sufficient amount was hauled to justify spreading and mixing. The sand on a part of the work was put down in two layers, each being worked in with a harrow. On this portion the road has stood up well, even though lumber and ties were hauled over it during the rainy weather. On the portion where only one layer was put down and that not thoroughly mixed, there is but little to show for it except in the track where the teams walk. But where the two layers were used and the mixing and crowning properly done the road did not rut seriously, except where shaded. In the heavily shaded spots, which happened also to be places where the drainage was poor, the wheels cut through and the whole width of the road became pretty muddy.

The Durham road from the town limits to the new bridge is the best example we have of a natural sand-clay surface. This material is from pits near the road, though it is exactly the same material as was excavated from parts of the cut along there. A part of it came from near the surface, while a part was taken from a considerable depth. The small gullies and ruts in the road surface proper are, in my judgment, due to the fact that much of this material had never been broken up so as to give the water opportunity to leach out sufficiently the more soluble portion. Therefore, when it was put on the road it first took up too much water, which made it expand, and hence more subject to the cutting action of the wheels. Then when so much material was softened it was easy for the additional rain to carry it away. If there had been only about half as much soluble material in these places the surface would have packed about as well and would not have absorbed so much water. For this reason I believe that this stretch of road will continue to improve for three or four years, during which time the less desirable material will leach out. This is, of course, conditioned on there being proper maintenance provided to prevent washing. One quality of the natural sand-clay mixture as it occurs in pits like these that gives it an advantage is the large percentage of coarse, sharp grains of the sand. In some cases it approaches a gravel mixture rather than sand-clay. I believe that, with a sufficient quantity of binder and filler, the resisting power of any sand-clay road is almost in a direct ratio to the size of the sand grains.

The topsoil surfaces consist of almost anything from light colored loam to coarse sand and gravel. In some cases the binder is clay, in others loam that contains very little clay. In some sections it is very difficult to find any suitable material for use on the kind of base that one finds in the same localities. This is especially true of the western ends of the two branches of the Central Highway through this county. There we had clay roads and but little sand or gravel near at hand. We used whatever gravelly soil we could find even though it contained considerable clay. Where the red clay was used it has given fairly good results. But in places where much light colored clay was used it gets dusty in dry weather and cuts in wet weather. In other places the soil was so sandy that it did not bind well when put on without being mixed with clay or loam. In these places it does not become muddy but the surface wears into holes, making it uncomfortable to ride over.

The best topsoil surfaces are found where the material was a very gravelly soil with a slightly sandy loam for a binder. Within reasonable limits the more gravel, the better the surface has held up. The dark soils have in almost all cases made better surfaces than the lighter colored soils, no matter on what kind of foundation they are compared.

If a topsoil is used that contains a binder in sufficient quantities it does not necessarily have to be mixed with the material of the roadbed, nor does it require to be mixed within itself if it is taken from cultivated land. Care, however, must be used in placing it on the road not to use consecutive loads from different portions of the field, as the soil with more loam and less gravel will be compacted more and leave a wavy surface. In many cases the surface would be improved if the topsoil were mixed artificially.

There occurs at a few places in the county a soil containing an almost black gravel. This gravel looks as if it would be an excellent surfacing material, but when used it quickly breaks down into the toughest clay to be found in the county. On examination it is found to consist of particles of the less soluble minerals from a granite, held together by the feldspar still in place but almost completely turned to clay. When the lumps are broken the interior is seen to be composed largely of clay, some of which is still granular. Therefore, when the outer crust is broken by traffic, the gravel immediately disintegrates to form a clay that is much less plastic than that which has been longer exposed to the air. In any section where the soil is derived from a granite or gneiss it is well to examine carefully any dark gravel before using it for road surfacing.

There has been only a small amount of bank gravel used for surfacing in this county. The Durham road from the flat bridge to the top of the first hill east of the little store was surfaced with a good grade of bank gravel. It has stood up better during the bad weather than any other piece of road in the county. The material occurs over a limited area in that section and in rather shallow deposits. The supporting material is largely quartz sand, but there is enough clay and loam in most places to bind it satisfactorily. At a depth of a foot or two the sand and gravel disappear almost entirely; the material there being practically all red clay.

The recent failures of so-called sand-clay roads have brought this and the allied topsoil surface into great disfavor. But I think it is not so much a failure of sand-clay as it is a failure to use sand-clay. If sufficiently coarse material and sufficiently little clay had been used, there would not be so many taxpayers swearing that their money had been wasted. But, as an old Scotchman said to me a few days ago, "There is always some reason given for the failure of these sand-clay roads," and what the people want is roads, not reasons. It is therefore, very important that in the future experienced and reliable men be put in charge of surfacing with these materials in order to redeem this type of construction. Otherwise many communities will be constrained to go for many years yet without road improvement because they are not able to build macadam and are not willing to invest their money in something that will not, in their judgment, prove satisfactory.

Reports from Counties

FRANKLIN AND VANCE COUNTIES.

By W. S. FALLIS, Road Engineer.

The cost of maintenance on water-bound macadam roads is excessive, as we all know; but to illustrate, I want to cite one example. Say a county

has quite a number of miles of macadam roads, totaling perhaps 250 miles. To properly maintain this it would cost them \$100 to \$150 per mile, say \$125 or \$31,250 for maintenance, and perhaps then they are limited to that amount of road work. If it take the \$31,250 a year to maintain their macadam roads in good condition, and this amount is the limit that the county can raise for roads, they are bankrupt in so far as the construction and maintenance of new roads are concerned. There is one thing we all ought to stress; that is, always build a road so it can be economically maintained, so the cost of maintenance will be as low as possible and within the means of the county. There are two or three things I want to say in that connection. We all understand that poor drainage is the greatest enemy of the road. There are several phases of drainage that affect the maintenance especially. One of the great troubles is a general lack of information as to the effect of the width of the road on its maintenance. A road that is built too narrow to afford proper ditches sufficiently far from the traveled part is a great deal harder and more expensive to maintain than one built of sufficient width to give proper drainage from the traveled part. I contend that you can build a road thirty feet wide through average level country where fills do not exceed eighteen inches and cuts do not exceed eighteen inches for as small actual cost of construction as you can build an eighteen-foot or twenty-foot road, for the reason that the handling of the outfits in making the narrow road, and keep from doing damage to property outside of the right of way is more difficult than for the wider road. In turning a road machine it is easier, and less expensive, to the work to turn on a wide road than on a narrow road. For these reasons I am satisfied that the little difference in the yardage to be handled will be overcome by the facility with which the work can be carried on.

The great advantage of keeping the water in the ditches at least seven feet from the edge of the improved surface is vital to the cost of the maintenance of the road, and to its continued good condition.

In Franklin County most of our roads this winter have been all right. We have had a few mud holes here and there, but nothing to cause any dissatisfaction with the kind of construction or cost of maintenance.

The road work in Vance County has not been maintained properly this winter, and I account for the five miles of bad road that I reported largely because the maintenance was not properly carried on in that part of the road. The road was built of a soil that had too much mica in it, and the rain falling on that, of course, softened the whole surfaced portion of the road, and it was not given any attention. I do not think this road would have been bad at all except perhaps a little pasty if the roads had been dragged immediately after every rain. The rain falling on the small ruts and depressions made by the wagon tracks and horses' feet were filled with water, and as this water was allowed to remain it softened the sub-grade and ruined the surfacing. If they had gone over this road with a drag and cleared the water off immediately after each rain, we would have had the road dry in a little while and the water would never have had an opportunity to injure the sub-grade and thereby ruin the road. As to the maintenance problem, in general, there is a good deal of talk of various methods involving the use of the motor truck and tractor as maintenance tools. These machines as at present developed I do not believe are efficient tools for the purpose. I believe, however, that we will get in a short time a good maintenance tool in some form in the light tractor. I do not believe there is any tractor or motor truck now made that is an

efficient maintenance machine. They are too heavy, and the slippery condition of the roads, if they are not used at the proper time, makes them practically impossible to handle. We use road machines and drags that only require from two to six horses to pull, and when we get a light tractor of that capacity, then we will have an efficient steam or power machine to handle the maintenance problems for sand-clay roads, but as long as we have to put heavy tractors, forty to fifty horse-power, of eight to ten tons weight, they are too heavy and costly to use on roads as maintenance tools. Among the other troubles in using a heavy machine, the bridges and culverts, as now generally built, will not stand them, but the light machines ranging from three to eight thousand pounds, and with a draw bar capacity of from four to eight horses, would, I believe, be a very efficient machine for economical maintenance, and, while I do not know of any developed yet which is a really effective machine, I believe that such machines will soon be on the market. With smaller machines, costing from \$500 to \$1,000, you can invest in four or more, say at the cost you now have to put into one of the larger kind, and thus keep four maintenance outfits at work at an investment cost no greater than is required for one of the large machines.

How is the maintenance done in Franklin County?

Four men and six mules have about sixty-five miles of sand-clay and twenty miles of other roads to keep up, and are doing some grade work in addition.

How do you arrange about dragging?

They have six mules, say, three drags, two mules to the drag. They go immediately after a rain and drag the road. Some of the roads have stood in good condition for a year without being touched, but local conditions control that entirely.

Is using farmers in different sections, trained to drag roads, a good method of maintenance?

If you have a man as superintendent in charge, held responsible for maintenance, and he is provided with automobile or other method, to see that roads are dragged promptly and properly, it should prove a good method in many cases.

Can two ordinary mules handle a drag?

If the mules are light, use a light drag. I would never advise a county to use a mule weighing less than eleven or twelve hundred pounds. The heavier mules can pull a pretty heavy drag, the heavier the drag, the better.

What is the cost of the outfit a year?

This cannot be answered definitely; perhaps somewhere around \$3,000.

LEE COUNTY.

By R. P. COBLE, Road Engineer.

Lee County has a somewhat peculiar condition. About three years ago they voted \$100,000 on property whose assessed valuation is five million dollars. A tax of 15 to 17 cents was levied on the \$100 worth of property, netting a revenue for roads of about \$8,000. Out of this, five thousand pays the interest on the bonds and about one thousand is applied to the sinking fund, a total of six thousand, and leaving about \$1,500 for maintenance of the roads. The total mileage in the county is about 300 miles. With that small amount of money, we cannot possibly get very far in maintaining the roads of the county. The bridges also have to be maintained out of this fund. Every \$100,000 additional bond issue on the county will require an additional

\$6,000 to take care of the interest and sinking fund. A levy of thirty cents will bring in \$15,000 a year; it will take \$12,000 of this money to take care of bonds and sinking fund, and the county will just have about \$3,000 with which to maintain the roads.

My experience with sand-clay roads is that they are not very difficult to maintain. The best method of maintaining a road is the split-log drag. I find that some of the road does not need dragging more than five or six times per year and some of the gravel roads have not been dragged a single time. The road machine has been over them a few times. The road from Sanford to Raleigh, about forty miles, was finished in February, 1913, and has not had \$20 spent on it since it was built. The surfacing material contains 75 to 80 per cent gravel and is good.

We have another piece of road in the county, about eight miles long that was finished about eighteen months ago and has had \$40 to \$50 spent on it. This road has had the machine used on it about twice. Some of the sand-clay road in the county has had no work done on it practically at all because it did not need it. Last year we cleaned out the ditches thoroughly, threw the material on the outside of the road and in this way eliminated all bad drainage propositions, and the roads at the present time are in fairly good condition.

Question: Did you examine the roads from time to time to see if they needed maintenance?

Yes.

Question: Were you keeping track of that road, so if you did have a bad place in it you could repair it or did you wait from one year to the next to do all that was necessary?

We had two or three bad places that should have been repaired. The trouble there is to find a man with experience to do this work. Unless I stop one of the foremen on the construction work and carry him back to do the work, it cannot be done. That is the trouble; to get a man with experience to do the work.

I am doing the dragging there by hiring farmers' teams. I give them about five miles each. They can do this in one-half day.

Question: How do you keep track of that?

I inspect roads from time to time and if I find a break in the road where there is not enough sand or clay, I have them haul sand or clay.

Question: What kind of gravel do you use?

White gravel.

CRAVEN AND WAYNE COUNTIES.

By R. E. SNOWDEN, Road Engineer.

I have not done much work in Wayne County. During the time I was there we have built two roads—the Pikeville and the Stantonsburg roads. We built these roads of first-class sand-clay construction, or possibly gravel construction with very coarse sand. The material was very close at hand. The roads were designed thirty feet wide ditch to ditch with twenty foot surface. We were compelled to do this owing to the heavy traffic just out of Goldsboro. This fall there was some misunderstanding between the road trustees and myself as to who was engineer, and I am not there any more, but during that time we completed these two roads. One of the trustees who lives on this road is very much interested in road maintenance. I keep in touch with

him at present though not connected with the job, and by a proper system of maintenance on these two roads they have held up almost perfectly during this wet winter. The type of drag we use is a combination of cutting and smearing drags. The front blade is vertical and sharp, shod with iron; the rear blade is in the shape of a trowel. The front is about two and one-half inches higher than the rear and we have found this drag very efficient in dragging these roads. In that way we have gotten an almost perfectly smooth and almost perfectly water-tight surface so far as water penetrating from the top through the bed is concerned.

Craven County road betterment is a very serious complication. We have 1,000 miles of road with about fifty or sixty miles of fairly well improved miles. Two years ago we began a patrol system of maintaining the roads. We were able to improve the roads very materially, but last June politics took control of the roads, and because we could not build at once by every man's house by our plan of work, they placed each township by itself under the supervision of three men in each township. That gave me twenty-four men to report to, twenty-one too many, so I withdrew from all road work in the county except the Eighth Township and the Central Highway through the county.

During the past year what politics did not do to the roads the wet weather has finished. I understand a bill has passed the present Legislature putting all the roads of the county under the supervision of one central plan. The Central Highway through the Newport pocoson was the only section in North Carolina not passable at all times of the year. I found it undrained, very flat and on black, peaty soil which was usually impassable. We improved this road by cutting large ditches and grading the edge off on the side next to the road and then hauling in soil from the savannah on each side of the pocoson, material known in that section under the local name of savannah soil, and covered the road to a depth of twelve inches. We dragged this road all through the fall and winter, and it held up very well during the wet season, much better than we expected. We find in working a road that is nothing but an earth road without any topsoil, that a great deal of good can be accomplished by cultivating the road just in reverse to the way a farmer cultivates his field—by getting out on a road and plowing while wet, to make a slop of it. In other words, you accomplish for the road what the farmer does not want to accomplish for his field, you make it stiff and hard and tight. Our greatest obstacles in the way of getting good roads in Craven County and a good many other counties in Eastern North Carolina is poor drainage and politics.

HALIFAX COUNTY.

BY N. C. HUGHES, JR.

As a preface to my remarks on road work in Halifax County for the past year, let me say, that we are peculiarly fortunate in one particular phase of the work in general, and that is, that the business of building roads in Halifax County is, so far as I have been able to discern, free from the shackles of politics. But on the other hand, there has developed within the past year a condition, the effects of which tend to work a hardship on road improvement throughout the country as a unit. This is, that within the last year or eighteen months, two townships, Halifax and Enfield, have voted on and sold bonds for road building. This step has necessitated the appointment

of a board of township commissioners for each township separate and apart from the County Good Roads Commission, whose duty it is to look only after the expenditure of the bond money used in construction of roads. These townships still have a general county road tax, the disbursement of which rests in the hands of the Good Roads Commission of the county. Here, it is readily seen, lies open a chance for some conflict of authority, but to date all matters concerning the expenditure of the separate funds have been neatly adjusted. Yet it is also evident that so many organizations for the same general purpose entail greater expense in the administrative department, to say nothing of the liability of a disunited effort in properly systematizing general road work for the county.

Connected with this condition is one which sometimes works difficulties upon the superintendent, that of having to deal with three distinct organizations composed of a total of twenty-one commissioners, with each commission having to operate under different conditions and different problems. And coupled with this state of affairs, he has to meet another proposition with strong moral suasion and some degree of diplomacy, that of pleading with the county commissioners who have solely to do with the appropriations for equipment for the regular county road force.

But beyond all this, the main idea has been and still continues to be that of building roads and better roads. Since June, 1913, we have constructed or rebuilt upwards of fifty miles of roads, about seventy-five per cent of which are sand-clay and clay-gravel roads and the balance good earth roads widened and reshaped and well drained. The average cost per mile of the sand-clay and clay-gravel roads was approximately \$1,100, and that of the earth roads \$500.

So great has been the pressure and effort to construct roads throughout the county that comparatively little effort has been expended either to maintain what has been built or to institute any maintenance system. Yet we are planning to try out within the next few months a maintenance system in one or two of the townships which already possess some first class roads, and we hope to be able to make a good report upon this trial next year. I feel constrained, however, to make mention of one township that has made more effort and accomplished more results in maintenance than any other one in the county, and that is Roanoke Rapids Township. The system in vogue is to be credited to Mr. John L. Patterson, of Roanoke Rapids, chairman of the County Good Roads Commission, who is perhaps one of the broadest gauged road men we have, and who certainly is one of the most practical. The actual execution of the system is entrusted to a superintendent who has two mules with two dump carts and drivers and an extra man or two as helpers when needed, one drag and two drag scrapers. He uses the dump carts for long distance hauling of surfacing material, the team for dragging when needed, a mule to each scoop for cleaning out the roadside ditches and slipping convenient surfacing material on the road, and the extra help for loading, shrubbing, cleaning out pipe and cutting storm ditches. This outfit for the year around costs on an average of \$100 per month, and with good management covers a total of about twenty-five miles. This makes the cost per mile per year for maintenance about \$45. But for the fact that quite a bit of fairly good reconstruction work is done along with this work, the maintenance cost per mile per year would, I estimate, be about \$30. This system, of course, was used upon roads which were under the standard in width and grades and were

only old county roads that have been gradually built up by this method of maintenance. They have stood up remarkably well under the hard, heavy weather of this past winter, and are better than second-class roads in the open seasons. It is true also that virtually all of our newly constructed sand-clay and gravel-clay roads have stood the test where they had been completed before October. The results in the latter cases being due, I have concluded, to a very free and frequent use of the road machine instead of the drag for reshaping and redressing. Certainly the drag is an admirable tool, but it is truer still, from actual experience, that a well constructed road can the better be kept in proper shape and condition by the use of the road machine upon it at least once in sixty days or ninety days at most. The heavier the traffic the more frequent should be the use of the machine.

As a final word permit me to say that I do not believe this organization could be of greater service and benefit to the State than to gather facts and figures relative to the maintenance of roads from every available source, both within the State and without, from men who have made actual tests along this line and whose testimony could be relied upon, compare these facts and figures, with all the extenuating circumstances considered, and then have the whole compiled under the efficient supervision of the State Geological Survey, whence copies may be conveniently distributed over the entire State whenever called for.

HARNETT COUNTY.

By IRA B. MULLIS, Road Engineer.

The maintenance in Harnett County is, as in many other counties of the State, done under the old six-day labor tax system. Under the new law of 1913, any county or township wishing to build improved roads has the right to issue bonds to do the work in this way, and fortunately this law always says that when any township issues bonds for road construction the road commission must maintain these roads by the use of the split-log drag or some instrument to keep the crown of the road in a smooth condition, and if they fail to do this they are guilty of a misdemeanor and upon conviction shall be fined or imprisoned at the discretion of the court.

WARREN COUNTY.

By SAM D. SCOTT, Road Engineer.

Some days ago Dr. Pratt asked me to make a report for Warren County. The roads in the townships which have no bonds are built under the old tax system. It seems to me that under these conditions about the best thing we can do is to use the patrol system and that is what I use in the township in which I am working. It is our intention to get these farmers together on different stretches of road and teach them the use of the split-log drag, because I find that the majority of people know nothing about the use of it. We want to get these farmers to agree to drag the five-mile stretch of road that he travels most and we want to make him a patrolman; make it his business to look after his particular stretch of road and report upon it. We usually suggest that they have the following tools: A split-log drag or drag of some kind, a shovel and perhaps a mattock, and also a ditch cleaning apparatus. Sometimes I clean about six miles of ditches for about six dollars on both sides of the road. We want to get these men together and teach them the use

of these tools. The trouble is the farmers will drag the roads at the time most convenient to them. I recommend that each man report to his supervisor (since we will not have any superintendent of maintenance or engineer) and that these reports be made out on some form, perhaps postal cards. This form should contain the following items: Time of rain; at what time the road was dragged after the rain; how many trips he made on the road; distance he dragged, use of harrow. He should send in to the man to whom he reports at least weekly, if he drags that often. In this way the supervisors can keep after the man doing the dragging. It seems to me that we will get about the maximum efficiency under some such system.

GUILFORD COUNTY.

By J. A. DAVIDSON.

Guilford County never did much in the way of topsoil or sand-clay roads until a few years ago, when they began to build topsoil roads. Where we have been able to get a quantity of good material, the roads have been very satisfactory and have stood up reasonably well. When you come to the question of maintenance, that is done largely by township commissioners. In our system of county road work under the present law, we have township commissioners, three in each township, and they are supposed to hire a superintendent to do what is necessary and to keep him out on the roads to look after the road forces and to approve his bills monthly for payment. That has not been satisfactory at all. I think it is owing more to scarcity of labor in the rural districts in each county than anything else.

We have been scraping out the ditches with a tractor. I have always insisted on the township commissioners putting their forces after this tractor to distribute the debris and fill up the holes after the tractor and in very few instances did we get anybody to do the work. I think the superintendent or the fellow who did the work on the roads would have to run down the commissioners and get them to approve his bills. It was very unsatisfactory and this feature of the work has been abolished, and now we are going to inaugurate a system of repair forces of convicts to be placed in different sections of the counties, which I think will give better results.

NEW HANOVER COUNTY.

By R. A. BURNETT, Road Superintendent.

You called on a bad man to make a talk. I am not much of a speaker. Gentlemen, you all want me to tell you what we are doing. The first thing we do in regard to maintaining roads is to see that they are all drained and the water kept off. The next thing, we have an automobile truck to keep stuff all along the roads throughout the county. We then have a maintenance gang that keeps the ditches clean and after every rain these people know where to go. They start out to find bad places and first get material like the road is built of to fill the holes with. If the hole is very deep, we use a lime rock, which we put in while the road is wet and on our roads there is a kind of mortar which will form a strong binder when mixed up by traffic. That is the way we are trying to maintain our roads and they are in first-class condition, and we have not had any trouble with our main highways this bad weather.

New Hanover is practically the only county at the present time that is

really carrying out a plan of systematic maintenance work largely by the patrol system. They have put in vogue the plan that the French have used in the maintenance of their roads.

MR. PRATT.—For the last two years since Mr. Burnett has started the systematic maintenance, he is getting splendid results. His maintenance charge is lower than any of you for a similar type of road. The system, however, can be used just as advantageously in other counties as in New Hanover and it is the only way I believe in the end by which you will get the best results from maintenance.

There has been considerable discussion about the maintenance of macadam roads and some think that the policy of just spreading stone on the road and letting the traffic pack it in was a bad idea, but I would like to ask if the stone he uses is not one with a high cementing value. I would like to know just what his stone is.

Answer: I cannot tell you what kind of stone it is.

I wish it were possible to follow a similar system in practically all the counties of North Carolina, whether macadam, sand-clay or gravel. If we could work out the principle of the system used in New Hanover County we would get satisfactory results in other counties.

REPRESENTATIVE FROM ROCKINGHAM COUNTY.—I have no report except by observation and it seems that our county is suffering from an overdose of politics. The first thing the new commissioners did was to turn off the best road man they had.

GREENE COUNTY.

BY J. ROY PENNELL, Road Engineer.

This county tried to vote bonds about a year ago and failed, and then voted bonds by townships. They thought each township would get a better show. They voted \$110,000 of bonds and let it by contract. We have just been spending that and have about sixty-seven miles of road built and have spent just about one-half of the money. There are four contractors in there, who will finish in twelve or fifteen months. We are building sand-clay and topsoil roads. We have not enough clay there to furnish a good base for topsoil, but we have plenty of natural earth roads. The sand is almost too fine to use. In regard to maintenance of sand-clay roads, one reason that they have gone down is poor air circulation. What we are doing down there is to cut down every tree that shades the road, every tree except in a man's yard. It lets the sun in to the road, dries the road out and lets the air circulate through there. In a good many places we have had trouble this winter, especially where we put fresh dirt in and it held the water and in other places where new material was put in mud holes which absorbed the water, instead of getting off the water first and then putting in the material.

Question: Have the townships made any special arrangements for a maintenance fund?

None whatever. It will take us about five months longer to finish up the money and I have been trying to get them to put in a patrol system down there. The type of road we are building will be worth very little without maintenance and a good many of the people seem to realize that now.

YANCEY COUNTY.

By WYTHE M. PEYTON, Road Engineer.

As I understand, the question to be particularly discussed today is maintenance. That is something we in Yancey know nothing about. I cannot tell you very much. Yancey County, I will say for the benefit of those who have not been there, has never had any roads. As I heard a traveling man say yesterday, he came into the county about a year ago, had to drive up to the courthouse, and drive back again and he said if he could ever get forgiveness for that he would never try it again. I think many of us will feel the same way. In those mountainous counties the trails, I will call them, which we have there are very steep, very rough, in many places dangerous, so that the Legislature, at its meeting two years ago, was kind enough to take into consideration that the people of Yancey did not know what roads were, did not know the value of them, and they took it upon themselves to authorize an act embodying a commission and authorizing this commission to issue bonds for \$150,000, which was done about a year ago. For the last twelve months I have been laboring on the economical expenditure of that amount. We have been building our grades through that mountain section over the ranges of the Blue Ridge, many five hundred feet higher than Asheville. Our main traffic line is about twenty-three miles long. You road men in the Piedmont and eastern sections no doubt will think that 5 per cent is an excessive grade and unreasonable, but the people of Yancey County who have been traveling over roads, some of which have a grade of 23 per cent and over, think it is almost marvelous to get a 5 per cent grade. Then on our spur or tributary lines we are maintaining a 6 per cent maximum grade. Then as for width, we have one mile of thirty-foot road from the town to the station, but only twenty-six feet through the county as two years ago compared with about twelve or fourteen feet, and occasionally a little bit wider. It is certainly a great improvement.

Now a large proportion of this construction work has been rock work, approximately 50 per cent. We have completed about twenty-three miles and have about twenty miles more under contract which we hope to build if our money does not give out. At present we have only spent about one-half of the issue.

Now, for the maintenance. As I said just now, for the trails we had in our county the old labor tax of six days or six dollars. Each able-bodied citizen between the ages of eighteen and forty-five years was required to put in at least six days or pay six dollars for the maintenance of roads. This work was done and is being done under the supervision of a township superintendent from each of the eleven townships. I am glad to say a few of these men are pretty competent, but in most cases are inexperienced men and the major portion of the money is wasted. I would like to see a better system organized. Furthermore, for the future maintenance of our roads we have a fifteen-cent levy, which amounts to about \$2,000 a year. As we have very little of our road graded and none surfaced, we at present have just the old dirt road to maintain, which we are doing with the old common split-log drag.

STOKES AND ROWAN COUNTIES.

By C. M. MILLER, Road Engineer.

Some men build roads and go somewhere else and build other roads, and leave their maintenance to the tender mercies of some moss-backed Democrat

or Republican, as the case might be, to maintain. Of course, you know the results. As I get older I am satisfied that the engineer who simply builds roads and does not take some steps towards getting these roads maintained is guilty almost of negligence. It is the most important part of the work.

In Stokes County three townships voted in all \$140,000. In Walnut Cove Township they appointed a nonpolitical board of highway commissioners—two Republicans and one Democrat. The two Republicans took the bit in their mouth and went on with it. They did employ an engineer, and the result was we got about forty miles of well-built road. It is true sometimes I took the bit in my mouth a little. Unfortunately the bill did not provide for a dollar of maintenance. It provided for a sinking fund. I had planned and I had the consent of the board to reserve from \$500 to \$1,000 of this money for a maintenance fund. When they found there was a change not only of commissioners but in politics, they decided to put out every dollar of that money in construction. The result is, the roads have not been bad during the winter. They stood up remarkably well. I was only employed to build these roads, and as soon as they were built my work was finished, in a business sense, but in a moral sense I feel that I have done very much like a man who will build a house and not provide a roof over it. We hope to get a bill through, and I think it my duty to help get the bill through the Legislature, providing for the maintenance of these roads.

In Mount Airy we have a model Highway Commission. They tell the engineer what roads to build and expect him to do the work; in other words, he is boss of the job, not only of the building and construction of these roads but of the maintenance. We have, however, a superintendent in only one township. He has on outfit of mules and does a good bit of topsoiling. Our roads are sand-clay. His duty is to watch these roads, fill up the holes, keep drags running and his road machine also.

In Rowan we have just lately organized what I believe is one of the biggest road maintenance systems that I have been connected with. In the first place we have an engineer. Under him we have a general superintendent, who has supervision not only of the construction but of the maintenance of all the roads in the county. The engineer makes the surveys, plans his roads, bridges, issues instructions to the superintendent, etc. He further confers with the superintendent in regard to the best methods of building these roads and of maintaining them after they are built. Under this superintendent we have two chaingang camps well equipped with the latest machinery suitable to our wants. In charge of these camps we have a foreman, who goes from one camp to another and looks after the maintenance work. They do the heavier part of the work. Then we have a patrol system, having men in the township connected by 'phone. This superintendent 'phones them when to go over their roads.

Another beauty about our work is that Rowan is a Democratic county, but we have no politics in our road work. I really do not know what the politics of our superintendent is.

EDGECOMBE AND COLUMBUS COUNTIES.

By J. W. MARTIN.

I have been in Columbus for the past fifteen months, and we have done some pretty good work during the past year. We have built about thirty-five

miles of good dirt road, but not much sand-clay. The material around there is not as good as in some counties. It is a low, flat country, a good deal of quicksand. We have built some few miles of pretty good sand-clay roads. The main road we built over there was from *Whiteville to the South Carolina line*. That road, if maintained as it should have been, would hold up and be a very good road during most of the year. They maintain the roads by working six days in the year. They either work six days or pay three dollars, which does more good. Besides building thirty-five miles of road, we have graded a great deal more road than that. They are behind now with their road work. They have had convict forces for several years, sometimes as many as seventy convicts. My average has been thirty-five during the past twelve months. I feel that the good piece of road we built last year has brought new life into road business in that county.

Edgecombe has a pretty good outfit now. We have been working roads in Edgecombe a number of years by taxation and by convicts; but our road building there has been more patch-work than building roads. We never attempted to build any good sand-clay roads until the last two years. I think the first piece of sand-clay road that was ever built there was about five years ago, but for the last two years we have been trying to do better work and the prospect is we will do better than we have done. We have two convict camps, about forty convicts in all. We had Mr. Fallis over there and we have done very good work and the prospect is we will do better in the next twelve months. We have a bond issue there of \$100,000 for roads and bridges.

DISCUSSION.

MR. PRATT.—From the remarks of Professor Strahan and Mr. Fallis; Mr. Snowden in regard to roads in Craven and Wayne counties; and Mr. Brown in regard to roads in Orange County, we find that sand-clay or topsoil or gravel roads have in many instances in all of these counties been bad during the past winter. As Mr. Brown said, there are undoubtedly reasons and good reasons why these particular sections of road in each of these counties have gone to pieces. Reasons will do for a certain length of time with some people; but it seems to me that the points which have been brought out this year have shown first that one of the errors—largely of the people themselves—is in regard to the cost at which they expect to build the sand-clay roads, meaning sand-clay, topsoil and gravel. We have too much of an idea that a sand-clay road is a cheap road, as far as cost goes, and that you can build a road anywhere from \$250 to \$500 per mile. Now it is absolutely impossible to make any statement whatever to any community or county regarding what a sand-clay road will cost in that community or county without making a complete road survey of the county or community; because the factors that enter into the cost of that road are not only the grading, but location of the road and the obtaining of suitable material with which to build or surface the road after you have graded it. If you have got to move that surfacing material a mile, compared with one-half mile in another section, it will make the road surfacing cost a great deal more. The people are asking us to build the roads too cheaply.

To my mind one of the qualities that you men here, representing the road builders present, must display in road work is to insist on thoroughness, not only in location but in every phase of the road work. That is going to be hard, because as Mr. Stacy has brought out, the minute the people have voted

bonds or placed upon themselves a considerable tax with which to raise money to build roads, they want the roads all built at once.

We have been carrying on considerable educational work throughout North Carolina regarding road construction. We have got to carry that still further now and show that in the end the best results not only to the road but to the people themselves will be not to hurry that work but to do it thoroughly and carefully, so that every mile of so-called improved road is made in the very best way it can possibly be done. If that had been carried out in all the counties, we would not have the reports we have had this morning in regard to sand-clay and topsoil roads.

In speaking about the selection of road materials, by simply going out and looking at it, reminds me very much of the way many a mine has been examined and reported on in the western part of this State. Instead of having an assay of the ore made, it was just looked at. I have a splendid illustration of that: I was called from here to New York and went over a proposition there. They had a little over one million tons of ore blocked out that they said would average $5\frac{1}{2}$ per cent copper. I asked them how they had determined it. They said, our superintendent has kept track of the ore and we know we have it. After my examination I found that they had practically blocked out about 1,500 tons of ore and had packed this ore. The way that it had been examined it looked like good copper ore. They picked out occasionally a piece of ore that they knew was copper ore, had it washed and it did carry a good per cent of copper. The million tons dwindled to something like 1,500 tons. The same precautions must be carried out in regard to road materials; you have got to have, first of all, a man of some experience and who knows about road materials. You must from time to time make tests of the materials to know if you are getting something good. You must be thorough about the selection of road materials. The whole difficulty we are now experiencing summed up is lack of thoroughness in the selection of road material, and in the method of putting the material upon the road. It may perhaps have been put on too late in the season when it had no chance to get thoroughly mixed and hardened before the rainy season came in.

MR. D. TUCKER BROWN.—I do not know that I can add anything further to what has been said in regard to the construction of a sand-clay road. In the details of construction, I find in the State of North Carolina that we have had failures in each of the counties. I am more familiar with the western part of the State. In the eastern part of the State it is hard to obtain clay and in the western part it is difficult to obtain sand. In Buncombe County they have a good deal of macadam road. They concluded it would be better to build their minor roads of sand-clay and the main traveled roads of macadam. Recently they have concluded it was better to resurface their macadam roads with some bituminous material and continue to build minor roads of sand-clay. In the construction of these sand-clay roads, they have had nobody who knew any thing about it. They had no engineer and they went about it in a haphazard way with not very good results, I understand. They put two things together, sand and clay, ran a harrow over it, and in dry weather it would look well. But during this past winter these roads have been very deep in mud. The people have come to the conclusion that these roads are failures. I often find that where these roads have not been supervised by a man who knew what he was doing they have been failures.

Dr. Pratt was speaking of Henderson County. Last year they put sand on

top of clay and left the roads for the traffic to mix. These roads were as disagreeable in summer with dust as in winter with mud. The failures in sand-clay roads built in this State are largely due to faulty construction, poor judgment in choosing materials, etc.; but I find that lots of times where a road has been built properly the maintenance fee comes in to be considered, and we have just got to get some way to maintain these roads. The cost of maintenance is a small item compared with construction, but a better system of roads will result in every county if the roads are properly and constantly maintained. I think where roads are constructed by engineers who know what they are doing and what materials they are using, that they hold up a great deal better and are easier to maintain than those built by men who go ahead in a slipshod way and call it sand-clay building.

MR. SPOON.—It has been my duty to look after roads from Fayetteville, N. C., to Cheraw, S. C. On this stretch of road I have almost every condition of sand-clay road construction. This is one thing I know from observation. A light, even cheaply built, sand-clay road constantly dragged will stand a more severe traffic than the more substantially built sand-clay road unmaintained. Mr. Tufts, who has charge of the roads in the community of Pinehurst, has, in my judgment the weakest sort of sand-clay mixture, yet it never rains that the roads are not dragged, and these roads are thus kept in good condition. There was a sand-clay road built from Rockingham north to Jackson Springs. The construction of that road was very cheap; clay was spread on the road and then a road machine was placed on that, and some more sand poured on to counteract the excess clay in it. A drag was immediately put on that road to be used every time the rains came. I passed over that road not many days ago on one of the rainiest Sundays we have had this year, and I made a speed of twenty miles an hour on that road, and very few feet had mud on it. I want to say that I know the remedy that kept that road up under such conditions was nothing more nor less than faithful dragging.

Now I want to say in relation to the sand-clay road, that the failure of the sand-clay road in North Carolina is due to two causes:

First. An incomplete or improper mixture.

Second. To neglect.

We need, my friends, supervision, intelligent and constant, and at the critical or right time. A sand-clay road that will stand as a sand-clay road must have attention at the right time, which is just following a rain.

MR. PEYTON.—When should the road be surfaced or sanded? Is it better to allow your new or crown grade to settle awhile? I am rather of the opinion that it is, because necessarily there are places which must be patched before putting on your surface of sand-clay.

MR. STACY.—If you take care of the traffic that will settle it.

MR. PRATT.—That is one of the questions—whether or not after constructing the higher fills, those fills will necessarily shrink—should you take care of that shrinkage on a percentage basis, and put your finished surface on it, or will the shrinkage break the crust of that finished material, or will the finished material go down gradually with it? That is the point I want to bring out.

MR. FALLIS.—I am inclined to think that the sand-clay should be applied as nearly as possible behind construction work. You cannot take care of the traffic on a newly built, especially a sticky, red clay road, for any distance

if a bad rain comes up. If there is any chance for a rainy season the road will become absolutely impassable and cause more trouble than can possibly result from the drainage of a fill. I would always build a fill sufficient to take care of shrinkage, provided the fill was not beyond the maximum and the shrinkage of the fill would make my grade excessive. I am of the opinion that I would always keep my sand-clay or topsoil just as closely behind the other construction as possible. There is another reason for this, and that is your outfit and camp make it more economical to finish your work close as you go.

MR. PENNELL.—The only objection I see to putting it on right after construction work is in going up to a bridge abutment. It will settle there and break while it is green, but it is very easy to have that fixed and new material put on after the balance of the road is completed. My experience has been that it is much better for the traveling public and more economical for the county to do the work while grading is going on and if it settles over stump holes, etc., pick up those places that have gone down, add new material, and your wearing surface is just so much thicker.

Question: At what time is it better to drag a sand-clay road, immediately after it rains, or wait till it dries?

MR. SPOON.—The sand-clay road should be dragged as soon after the rain has fallen as you can. I want to be clear on this point. A road that is not a sand-clay road has no business to be dragged then. A clay road should not be dragged in a rain because it sticks and lumps; but when a sand-clay road has the proper composition, there is not enough clay there to give it this lumping quality. The excess of water that happens to remain there in the depressions is very probably taken care of by the drag, bringing in new material and forcing the water out. As soon after a rain as possible a sand-clay road should be dragged.

Question: What weight of drag do you recommend?

I would not advise an extremely heavy drag. I use a wood drag of sufficient weight to hold steady with two or three mules, then additional weight ought to be a movable quantity, because many times you want to so transfer weight from one point to another to make a deposit of material where necessary to keep the road smooth.

MR. FALLIS.—I want to say in reference to the failure of sand-clay roads this year, that more miles were constructed during the past six months than ever before. The facts are that we had less rain in the months preceding December and January than during such a period for two years; consequently many of the roads throughout the country had never been wet or mixed, and this is the first time in their history that they were ever thoroughly mixed, so they went down. The only thing we need now is to work faithfully till we get them firm and shaped up during the spring, and we will never have this trouble again.

Question: Do automobiles help roads?

MR. SPOON.—The Pinehurst roads are the finest, most ribbon-like roads I know of, and if subjected to traffic, such as that on the roads leading to Durham, Raleigh, etc., they would not stand up. But we do have one or two motor trucks that go over these roads every day and they are standing up.

MR. DAVIDSON, OF GUILFORD COUNTY.—We have about one thousand miles of public roads and we have over three hundred miles of improved roads. I am county auditor, and in addition am general supervisor of roads. I have en-

joyed this discussion and I think we have all seen the difficulties we labor under owing to different conditions. There is one thing we have got to work out, and that is the manner of maintenance after we have built the roads. In my county we had a road law appointing three commissioners in each township. We spend about \$11,000 each year in those townships, and those commissioners hire what they call a foreman who goes out and does the work. They O. K. his bills. They come in and the board of commissioners pays it in each township. It has been a failure almost completely. It is hard to get a responsible fellow to do the work. We have got to work out some way of keeping up those roads, and I have been after our board of commissioners to get a practical motor truck with a maintenance squad for improving roads. We can put a half dozen convicts in it, go to the road needing repairs, and get back to the jail that night.

WEDNESDAY AFTERNOON.

DR. PRATT: The first talk on the general subject of bituminous material will be made and illustrated by Mr. Frank Whitfield, representing the Barber Asphalt Company.

Use of Bituminous Compounds in Road Construction

BY FRANK M. WHITFIELD,

Representative of the Barber Asphalt Paving Company, Philadelphia, Pa.

Our director has chosen a very hard subject for the subject on which I am to address you. It is hard due to several reasons. First, because there are so many branches to bituminous compounds. To bring this down to a basis where we can more readily understand the subject to be discussed we will call it "Asphalts in Use in Road Construction."

Asphalts are divided into two classes, viz.: The Natural Lake Asphalts and the Oil Asphalts or Artificial Asphalts.

First, we will take up the soil asphalts and will look a little into them. Some years ago the only oil asphalts in use to any great extent were the residues from the distillation of crude oil found in the California oil fields and which were sold under the trade name of California Asphalts. Prior to placing these on the market, refiners of crude oil used to haul these so-called asphalts out to sea and dump them into the water. Then a chemist came along and advised the refiners that the residue "looked like asphalt, smelled like asphalt, and had some of the characteristics of asphalt," so they put this residue on the market for sale in road building.

Later on oil asphalt was obtained from the distillation of crude oil found in the mid-continental oil fields, from the Texas oil fields and from the Pennsylvania oil fields. These residues from the distillation of crude petroleum were placed on the market under various trade names, such as Texaco, Standard, Sarco, etc.

Then about three years ago several companies commenced importing crude petroleum from Old Mexico, from the oil fields around Tampico, and are now placing on the market the residue from the distillation of this oil under various trade names, such as Texaco, Aztec, Montezuma, etc., and the use of the oil asphalts from the distillation of crude petroleum from the mid-con-

tinental, Pennsylvania and Texas oil fields has almost ceased. There are many reasons for the discontinuation of these oil asphalts in road construction, the main reason being that there were numerous failures of these materials due to their non-uniformity and failure to withstand severe "service tests" when placed in streets and roadways. The oil asphalts from Mexico have as yet to demonstrate what they will do, as no streets in the United States constructed with these asphalts have been down over two and one-half years.

Now we come down to the class of asphalts that are REAL, and they are the asphalts which I have the pleasure of representing before you today, Trinidad natural lake and Bermudez natural lake asphalts—the only two natural lakes of asphalt known to the paving world today that are used in various methods of road construction.

First, we will take Trinidad. Trinidad natural lake asphalt comes from a natural lake of asphalt located near the coast on the Island of Trinidad in the British West Indies. This lake of asphalt has no doubt been exposed in its natural formation to the winds, heat and storms for hundreds of years—no one knowing for just how long—but it is said that the inhabitants of Egypt used Trinidad Lake asphalt for embalming their dead and that Noah's Ark was made water-proof with Trinidad natural lake asphalt. (Laughter). However, be that as it may, we do know from our experience that Trinidad is the father of asphalts, and we have streets constructed in the United States with Trinidad asphalt which have been in actual service for over thirty-five years with a very small maintenance, and hundreds of thousands of square yards which have been down over twenty years and are still giving excellent service. This service "test of time" under varying traffic and climatic conditions has proven beyond a doubt what genuine lake asphalt from Trinidad will do in road construction.

Now we come to Bermudez natural lake asphalt. Like Trinidad it is a natural lake of asphalt, but is located in the State of Sucre, Republic of Venezuela, South America. This lake of asphalt, like Trinidad, has no doubt been exposed to the elements for hundreds of years until, through a natural process in the course of time, it has refined itself, like Trinidad, and the company I represent is offering these two natural lake asphalts to the city and county officials of the United States and other countries for use in building good roads and streets.

In addition to offering you these two natural lake asphalts for use in road construction, we are backing our offer up by our over thirty-six years experience in the paving business, during which time we have gone clear through the "experimental" stage and have kept on from year to year importing and selling Trinidad and Bermudez asphalts under their own names, and have not tried in all this time to palm something off on city and county officials which we believed "as good as" the natural lake asphalts, and all the time our business has continued to grow and expand until we have Trinidad and Bermudez laid from Canada to the Gulf and from the Rockies to the Atlantic Coast, under all kinds of climates and traffic, and our business has increased every year—surely proving beyond doubt that we have materials in a class by themselves and which, so far, have never been successfully imitated except in color.

I have with me several reels of moving pictures showing the lake asphalt industry, and if you will give me your attention for a few minutes I will run

these pictures through and show you by motion pictures how Trinidad and Bermudez are mined, refined and used in road construction.

First, we have a view showing Trinidad Lake, showing the natives picking the asphalt from the surface of the lake. This is picked out with ordinary picks, loaded into the cars you see in the picture and transported on the small track you see in the picture to the docks; the buckets into which the asphalt is loaded on the cars are then picked up by an overhead cable and carried to the ship alongside the wharf and dumped into the hold of the ship.

Next, we will take a look at Bermudez Lake. Like Trinidad, the asphalt is picked from Bermudez Lake. You will note the men work sometimes up to their waists in water. This asphalt is also loaded on small cars, and from these small cars, is placed on flat cars and transported to the dock by railway—Bermudez Lake being located about seven miles inland. Notice the shape of the pieces loaded into the buckets, and then notice the asphalt as it comes from the buckets. It has naturally welded together in transportation. I might add here that it was considered quite an engineering feat to build this railroad which you see in the picture, as it goes through practically an impenetrable swamp.

Next, we see the train arriving at the dock and the asphalt being loaded into the hold of the ship. Notice that the asphalt has again welded together in the shape of the buckets into which it was loaded. Now the boat proceeds down the Gulf and into the Atlantic and on to our refinery at Maurer. Then we see the men picking the asphalt from the hold of the ship as it has welded together in transit. The asphalt is then placed in open stills and heated to about 350 degrees F., in order to remove the water and debris that naturally accumulates in the asphalt as it comes to the surface of the lakes. I want to add here that in this manner of refining is where the natural lake asphalt has one advantage over the residuals or oil asphalts, in that we refine it at low temperatures, whereas the oil asphalts are often heated to as high as 1,000 degrees F., in order to get the high-priced oils out, out of which the refineries make their great profits. Next you see the asphalt being drawn out into the barrels, which are first clayed in order to prevent the asphalt sticking to the barrel. It is then cooled and is ready to ship to various parts of the world to be used in road and street construction.

While some of you gentlemen may not be so interested in street paving as in country road paving, I am going to show you next just how sheet asphalt pavements, the highest class paving known to the paving world, are mixed and laid.

We see in this reel the asphalt being loaded onto barges, this particular shipment being for a coast point. Next, it is being unloaded at the paving plant of the contractor. This picture is a municipal stationary plant. The barrels are cut open, the asphalt carefully weighed and carried to the stills where it is fluxed; that is, mixed with a fluxing oil in order to make it of the proper consistency for use in mixing with the mineral aggregate of the pavement, making what we term an asphalt cement. We next see the plant making the binder course for the pavement, that is, a mixture of stone, sand and asphalt cement, which is used to form a bond between the wearing surface and the concrete base of the pavement. This is carefully weighed and mixed and hauled to the street in bottom dump wagons as shown in the picture. We next see the concrete base being laid, this base being six inches in thickness. The concrete base for a pavement varies in different localities—the

character of the traffic it is to be subjected to and the subsoil being guides as to what depth to lay the base. The concrete base is mixed in an approved mixer, same being composed of sand, stone and Portland cement, the usual proportions in our territory being one part Portland cement, three parts sand and six parts stone or slag—one part being equal to four cubic feet. Next we see the binder course, which we just saw being mixed at the plant, being dumped on the concrete base. This binder course is then raked and rolled with a steam roller until thoroughly compacted.

We will now go back to the plant for a while and see them mix the sheet asphalt or the wearing surface. In making the wearing surface, sand is carefully graded from 10-mesh up in order to get as few voids as possible in the mass; it is then run through sand driers and into the mixer; then the filler, which is either limestone dust or cement, is added to the hot sand cold, and the entire mass is then mixed with the hot asphalt cement, the asphalt cement being about 350 degrees F., when mixed. The mixing is kept up in a pug mixer until all particles of the mineral aggregate are thoroughly covered with asphalt. It is then dumped into bottom dump carts, the same as the binder course, and hauled to the street, where it is dumped onto the binder course and raked and thoroughly rolled with a steam roller, after which cement or limestone dust is swept over the surface to take off the black appearance of the surface, and the street is then open to traffic, and you see in the picture the highest type of pavement known up to the present time, provided it is made with natural lake asphalt.

We see next a view of Fifth Avenue near Forty-second Street, New York City, acknowledged to be the heaviest traveled thoroughfare in the Western Hemisphere. You get a fair idea of what this tremendous travel is from the picture. A pavement laid on Fifth Avenue with Trinidad natural lake asphalt withstood such traffic for nineteen years before being taken up, and the stretch was relaid with Trinidad. This is proof beyond a doubt of the lasting quality of natural lake asphalt.

We will next look at a bituminous macadam pavement, mixed method, which is the highest class of pavement for country highways, and I might add that sooner or later we in the South are surely coming to the improved hard surfacing of our highways, as it is a foregone conclusion that plain water-bound macadam is a thing of the past and the ordinary roads are fast disappearing. We see here what we term a typical country road. Notice the badly rutted surface of this earth roadway and how difficult it is even to go over it in an automobile. Next we see this roadway being excavated for the base. This picture explains itself. We next see them dumping stone for the foundation on the road. Broken stone foundations are used on a great many country roads, as it cheapens the cost of the roadway. The base is then thoroughly rolled with a steam roller, and if any uneven or soft spots are noticed new stone is added, and the rolling is kept up until the surface is solid and the stones do not creep in front of the roller. We next see what we term a portable plant, that is, a plant which can be moved to a point near the country road to be paved. The carefully graded stones of the bituminous mixed macadam roadway are mixed with the hot asphalt cement and the entire mass mixed in a pug mixer until all the stones are covered. The top is then hauled to the roadway and spread on the broken stone base in much the same way as the binder course of the sheet asphalt pavement. It is then rolled until thoroughly compacted with a steam roller. Over the top of this is then

spread a seal coat in order to make the roadway absolutely impervious to water and close up any small voids in the surface. This seal coat is one-half gallon of hot asphalt per square yard, and over this is spread pea grit and the surface then thoroughly rolled, and the road is then ready for use. You will notice in the picture the kind of travel over this roadway after being paved with bituminous macadam by the mixing process. Such a roadway will surely prove a lasting investment to a community especially if built with Bermudez as "Bermudez stays put."

On our next reel we see what we term the resurfacing of an old water-bound macadam road by the penetration process. First, the old macadam is torn up with a scarifier and the sub-surface rolled. On top of this is placed stone one and one-half inches in diameter. This stone is raked to the grade of the roadway and left porous. Next, there is spread in this stone hot Bermudez asphalt heated to about 350 degrees F., to the amount of about one and one-half gallons per square yard of surface. This hot asphalt penetrates down into the inch and a half of stone and thoroughly coats the stones. There is then spread over this stone screenings about five-eighths inch in diameter and the road is then thoroughly rolled with a steam roller, forcing the stones of one and one-half inch dimension thoroughly together, and also forcing some of the five-eighths inch stone into the voids between the larger stones. This rolling is kept up until the road presents a smooth surface. Next is added to the surface one-half gallon of hot asphalt per square yard, and immediately over this is spread stone chips of about five-eighths inch dimension, and the road is again thoroughly rolled. This last course is what is known as the seal coat. The road is then open to travel. This class of roadway is very economical for country roads; is easily repaired and is rapidly gaining in favor wherever used. Buncombe County of our State is going to build this year some 100,000 yards of this class of roadway, and once started I feel confident that other progressive counties will discard the old temporary road building methods and build hard-surfaced permanent roads which are always the cheapest in the long run. When such roadways are built of the tried-and-found-true Bermudez they will last a great deal longer, as "Bermudez stays put."

Now, our last reel is one that is especially interesting to you gentlemen who have any water-bound macadam or gravel roadways that are showing signs of disintegration. This reel will show the surface treatment of such roadways with Trinidad liquid asphalt. We will go back to the island of Trinidad for a few minutes in this picture. We see here oil wells which were drilled by our company around the edge of Trinidad natural lake of asphalt. At a certain depth we struck a natural flow of asphalt in a liquid form, and you see in the picture the liquid asphalt flowing out of the wells and into holes in the earth, as when we first struck this liquid asphalt we had no tanks built and had to take care of it in these earthen tanks. This Trinidad liquid asphalt is brought into this country in tank steamers and is then shipped to various points of use in tank cars. We sell this Trinidad liquid asphalt in two grades—our Trinidad liquid asphalt "A" being for cold-surface treatment, and our Trinidad liquid "B" being for hot-surface treatment. All of our tank cars are equipped with steam coils for unloading, and we see in this picture the tank cars being unloaded into distributing wagons. The method of treating old macadam or gravel roads with Trinidad liquid asphalt is to first sweep the road surface cleanly with a horse-drawn broom. Next

is applied about one-half gallon of either the cold or hot material, whichever is accepted, and then immediately, as shown in the picture, stone chips are swept over the road, so that about a cubic yard of screenings or stone chips will cover about forty square yards of surface of the roadway. The roadway is then rolled—although with the cold treatment this is not absolutely essential—and the surface should be kept barred from traffic for about forty-eight hours. The roadway will then be ready for use. Such a treatment for a roadway is very economical, and when Trinidad liquid asphalt is used it forms a truly asphaltic surface, impervious to water, absolutely dustless, noiseless and very durable. This treatment should be repeated in about eighteen months, and eventually you will find after about three treatments you have built up a thick asphaltic top which will give you years more wear, and the whole treatment has been exceedingly economical.

Now, gentlemen, one word more and I am through. Get right in this road building. Build good, solid, lasting asphalt roadways and use good natural lake asphalt in such construction, and after a few years you will find that you will not have to assemble here each year and try to determine the kind of roadways to build, but will assemble for the purpose of advising others how stable and lasting your roadways are, and when the heavy rains come, as we have had in the past two months, you will not have to lie awake nights figuring on how many miles of roadway you will have to rebuild, patch, etc., but will be secure in the fact that your road will be there in the morning ready for use, for "Bermudez stays put." I thank you and would be pleased to answer any questions I can, either here or while I am here in the city. I can always be reached for consultation on the question of road building in my office at Atlanta, Ga.

Specifications: A Discussion of Their Importance in Road Building

BY BRENT S. DRANE, Consulting Engineer.

Several times in the past it has happened to me, gentlemen, when I have attended conventions like ours now, expecting to gather valuable ideas on some subjects set for discussion by men eminently qualified to handle them, I have come away disgusted; the men who had the experience spent too much time in proclaiming their eminence and the things they could do, and too little in telling the rest of us how we could do those things better.

That has made me timid in setting myself up like this; and I am going to ask two things of you: First, to understand that if I shall seem to recommend technical men, I am not talking about myself; and second, to charge my dryness partly, at least, to my effort to deal in facts to the exclusion of personal fancies.

"Contracts and Specifications" is the subject you have assigned me. I shall ask you to let me reverse the order, and take up specifications first.

"Specifications" is a word unfamiliar to the average man until a graduate lightning-rod agent undertakes to sell him an automobile; he then gets sick of the sound of it. I shall therefore not take an automobile as my text, but a wagon.

If one of you should be going to buy a few wagons for road work, you would, I believe, consciously or not, use a considerable amount of care and first-class judgment. First you would decide to fit your funds and the class of work before you, what *kind* of wagon you wanted, whether slat-bottom or dump-body. Next you would consider, in deciding on the particular make

you would buy, (1) how it would *pull*, involving its weight, the tire width, its length of coupling; and (2) how it would *last*, involving the material used in it, both kind of material and grade of material, and size and thickness; and most particularly the way in which it is put together.

You would probably decide, on the basis of your own observation and experience, the best way, if you have had these; or, if you had not, then you would be guided by the judgment of somebody whom you knew *had* had experience that seasoned his judgment, and who had no personal axe to grind, and would advise you honestly and for your best interest. In that case you are apt to get something which *experience* has proven to be honestly *constructed* on the right *principle*.

Now, there is right much in common between the way in which you would get the most out of spending five hundred dollars in wagons and out of spending five hundred thousand dollars in roads. What has made the particular wagon you bought worth your care and judgment in its selection is, first, the best *specification*, and, on top of that, honest *construction*.

A specification is nothing more than a set of principles laid down clearly and unmistakably, which have been evolved from, and which embody the results of, long and costly experience in the kind of work they cover. The factory that made your wagon, after having the benefit of the general experience of the ages in evolving wheeled vehicles, has probably spent many thousands of dollars on its own hook in costly experimentation, in arriving at the specification which to its managers seemed just right.

Similarly, the world has spent billions of dollars of wasted money—enough to put asphalt pavements on concrete base over all the highways all of us together ever saw I do not doubt—in learning how to build the best road for the money. Manifestly, in coming to a decision as to how to spend our road money, we should not fail to use the care and judgment that will insure our getting in full the benefit of all that money spent in experience that has evolved the best road specification for our purpose; we should use just about one thousand times as much as was done in the case of the wagon.

The proper selection of the road specification is, of course, very many times more complicated a matter than was that of the wagon. How it will pull, and how it will *last*, are still our main considerations; but in this case proper location, proper grades, proper drainage, proper surfacing materials, and a proper combination of the materials, all form an exceedingly complex and inter-related problem, a balanced solution of which is necessary in order to insure that we shall get the complete specification which will secure the largest public benefit for the money spent. In every one of these details, dearly-bought experience of others has made it possible for us to avoid, if we are sufficiently careful to learn and profit by past experience, the mistakes that have been made before us. We certainly do not want to spend the public money in doubtful experiments in roads, any more than we would in our wagon building in the local blacksmith shop, as long as there is this great fund of experimental knowledge already at our command.

Already, I hope, I have made clear enough to you the prime importance of getting the best and most complete specification for our road, whether we build it ourselves or let it out to be built by a contractor; the specification does not at all depend for its usefulness on a contract attached to it; it is absolutely necessary to us whether we make a contract or not. We are ready, then, to discuss means of securing the best specification for the road we are to build.

In the case of the wagon, we delivered ourselves entirely into the hands of the man or corporation who we knew built the best wagons, after we had supplied the judgment that determined the class of wagon that would be cheapest for us in the long run. In that relatively simple case we knew that honest *construction* was sold with the best specification; the established business success and continuance were involved in his keeping up his standard of excellence.

We are after the same thing, essentially, in our road building. No fair man would claim that it was impossible to find a road contractor experienced enough and honest enough to deserve our confidence in delivering ourselves entirely into his hands, to locate our road, grade it, and complete it; doubtless there are cases where this proceeding would result honestly and satisfactorily. But as long as human nature is what it is, there are few of us who would like to risk many hundred thousand dollars and the confidence our community has placed in us, on a business arrangement which places a man at both ends of a contract in that way. What we must have, to be faithful to our responsibilities, is a man who has absolutely no interests at heart in carrying out our affairs, except *our* interests. What we must have in order to be sure that we are getting the proper complete specification, is a *practical* man in the business, who is absolutely *our* man.

You probably thought I would say "a road engineer," didn't you? I do not say that; you certainly do not want a man whose only qualification is that he knows how to run land lines with engineering instruments, and calls himself a civil engineer. Neither would you be entirely safe in his hands on the basis of his further claim to have studied all the books and bulletins published on road construction. There are thousands of good, honest men who know more than they can understand.

What we must have, in order to plan in detail beforehand—that is, to draw specifications—for important road work, is a practical man who is not only experienced himself in that kind of work, but who has studied just as widely as possible the experience and the mistakes of others, and digested the results of his study so that he can apply it. Equally, of course, your man must be incorruptibly honest. It seems evident, then, that to secure our necessary share of the definite knowledge that experience has made available for us in all parts of the world, we have got to look for a certain amount of education in our man. And when we find him, who seems to combine the qualities we demand, I am frank to tell you that I believe we will find him calling himself an engineer of some kind.

If my reasoning has been convincing to you thus far, you are now ready to ask me where to find such a man and how to be sure of him when you see him. Certainly you have no inclination to give yourselves completely into the hands of any man who comes up, makes a good appearance, and says, "Gentlemen, here is my school certificate as a highway engineer; I am therefore the custodian of the wisdom of the ages in all matters appertaining to planning and building roads." I confess to you with shame that I am not sure. It seems to me, however, that in lack of any clearly established standards for such men to meet before the law of the State, that the most practical move to make is to consult very fully with the State Highway Department, and endeavor to secure its approval of the qualifications of the man who is to decide questions on the proper solution of which will depend so many thousands of dollars of profit or loss in such a matter as the spending of the average road-bond issue is likely to be.

And now I am afraid that I have worn you out with specifications, and still there is the subject of the contract to be touched on; and in connection with that I shall run over the headings that proper specifications should always cover. But it seems to me that the supreme importance of devoting the utmost care to the preparation of the plans and specifications in advance of going into the work, has been worthy of all this time you have let me give to it.

THURSDAY MORNING, FEBRUARY 25.

MR. PRATT.—The subject for discussion today is perhaps one of the most important phases of road work and one of the hardest problems connected with road work that we now have facing us in North Carolina, i. e., THE MAINTENANCE OF PUBLIC ROADS. I want to say a few words in opening this discussion, and then call on each county represented and hear from it as to whether there has been any method worked out or attempted to be worked out in regard to the maintenance of its public roads; and, if so, has the engineer had the hearty coöperation of the local commissions in trying to put into practice the method which he believes would be a satisfactory method of maintenance of roads. There is no question whatever but that in North Carolina today we can obtain without very much trouble the money necessary with which to construct roads. It is not very hard now to go into a county, and by a campaign of education get that county to vote bonds for good roads, provided you can assure the people of the county that in the bill providing for the bond issue you have certain restrictions in connection with the expenditure of the bond money that will insure that the bond money will be spent under the supervision of competent men. The hardest problem confronting us today is the question of the maintenance of roads; and it has been found extremely difficult to have included in the bill authorizing the bond issues a definite clause in regard to the maintenance of the roads after built. Undoubtedly, one of the factors, or one of the causes or reasons, that has worked against the good road work of North Carolina has been the fact that so many counties have built roads and then let them go to pieces. We must realize that the minute a road is constructed we must begin to maintain it; I think a good illustration of the truth of this statement is the \$11,500 per mile road built in Wake County. It is a section of the road leading from Raleigh to the Country Club. It was supposed to have been put down in as nearly as perfect condition as the people could obtain. It is a concrete road with a thin surface of bituminous material and screenings on top of that. That road was not maintained, with the result that on one side of it a section of the surface approximately fifteen to twenty feet long and three to four feet in width has broken off and dropped down about one inch or more below the balance of the road. The bituminous material has peeled up in spots and the surface is pitted in a similar manner as smallpox marks the face. The concrete has cracked in several places. The point I wish to bring out is that there was no provision whatever made by the county to take care of that road. Since it was put down I do not believe the county itself has done anything to maintain it as it should in first-class condition. As I stated before that mile of road cost \$11,500, and you would expect to have obtained a road that might have gone a year without any maintenance charges, but it did not even go six months. This emphasizes the point that all roads need constant maintenance.

When we come to the other forms of surfacing materials such as bituminous, macadam, gravel, and sand-clay, the question of maintenance is more acute; and it is absolutely necessary that maintenance should begin as soon as the road is completed. We were talking yesterday in regard to thoroughness in our work; but no matter how carefully the grading of a road may have been or how careful and thoroughly the surfacing material may have been put on, there is always a chance that a weak place may develop in the surfacing material. This very often begins to show itself by a slight depression, but if we have a method of maintenance in force, these depressions will be repaired as soon as noted. If you will notice when the maintenance work is done in many counties, you will find that apparently the county authorities have decided that only during a certain season in the year will they do any repair work or maintenance on the roads. Very often that particular time of the year is not the time of the year when roads should be repaired. As brought out yesterday in regard to surfacing, do not begin to repair your dirt or sand-clay roads just as winter is coming on when they do not have a chance to become thoroughly packed and solidified before the winter rains and freezes begin. I have seen a great deal of maintenance work done in North Carolina just at that season of the year. Do repair work in the spring and summer; but do maintenance all the year. In planning your method of maintenance, do not pick out any one season of the year as the only season when maintenance is to be done. Maintenance should be continuously done all the year. If necessary, it should be done every month, every week every day. Maintenance should be done when the roads need it, for, if you do not, the maintenance charges are going to constantly increase, and finally you will have a repair bill that will be many times in excess of an annual maintenance charge.

With the sand-clay, gravel and topsoil roads, if such roads have been thoroughly graded, and the surfacing material has been put down thoroughly and carefully, there should be no trouble in maintaining these roads in first-class condition throughout the year at a cost of \$50 per mile per year. This, however, cannot be done if you drag the road only once or twice a year. You must drag the road after every heavy rain. These rains may soften the surface one-quarter to one-half inch deep, but if the road is dragged right after the rains, these incipient ruts will be ironed out smooth and hard. I believe the reasons why some of the counties have been able to have good roads during this past winter will be brought out in the discussions this morning.

With the water-bound macadam road the question of maintenance is a great deal harder problem and more expensive than it is with sand-clay or topsoil roads. As stated, I believe it is possible to maintain a sand-clay or gravel road in good condition for approximately fifty dollars per mile per year; and every county should provide fifty dollars per mile per year for the maintenance of these roads. With the water-bound macadam the cost of maintenance will be very much higher. I believe the smallest amount we can get along with is \$125 per mile per year in maintaining a limestone macadam. Macadam roads made of diabase rocks, or trap rock, will cost from \$150 to \$175 per mile per year for their maintenance. If soft porphyritic or gneissic rocks are used in making the macadam road it will require from \$200 to \$275 per mile per year to keep such a road in good condition. While limestone is a particularly soft rock (composed of particles of the mineral calcite) yet on account of the ease with which the particles of road will cement together, the cost of maintenance is reduced. Where diabase rocks are used which have greater

cementing value than ordinary white granites and gneisses, the cost of maintenance of roads built of the former rock are much less than those built of the latter. Now, if you do not maintain a water-bound macadam road constantly year by year, but instead let it go for several years, you will find, when you do come to repair it, that the cost will be something like twice what it would have been if you had maintained it year by year. We have plenty of illustrations of this in all the counties of the State, as Durham, Guilford, Mecklenburg, Buncombe, and, in fact in every county where the macadam roads have been built. The old idea regarding macadam roads was "that when once built they would remain first-class roads without any repair work being necessary." About two years ago the road leading out from Asheville towards Fairview, which had been down seven years, was in very bad condition. The commissioners were obliged to remake that road at a cost of approximately \$1,900 to \$2,000 per mile, nearly twice what it would have cost if they had maintained it year by year. Take for instance the road between Chapel Hill and Durham, to bring that back as a first-class water-bound macadam will cost at least \$2,000 per mile, and it has not been done ten years.

Now another thing in connection with maintenance which we should keep in mind is that as you maintain your road regularly and constantly, you are decreasing your cost of transportation for those who use the road. Take a macadam road that is wearing out, and the cost of hauling over that is very much increased as compared with the hauling over a smooth macadam road. The cost to automobiles going over such roads is high, some automobilists claiming that it costs per year in tires alone more than enough to put the whole road in first-class condition. We all know that loose rock is very hard on automobile tires. In making the trip from Atlanta in connection with the *New York Herald-Atlanta Journal* tour, we traveled the valley pike from Winchester to Staunton, Va. The party paid something like \$340 toll for the privilege of riding over the road; but it was estimated that the tires were damaged to a greater amount. The method of repairing the road at that time was simply to crush the rock, which was placed on the roads and left for the teams to crush and pack. The first repair work on this Durham pike was very much the same—the loose rock put on with a little clay to hold it and then left for the teams to crush, grind down and bring into shape.

When it comes to building improved roads, I do not believe it is a feasible or practical proposition to build more miles of improved roads—surfaced road—than you have provided a maintenance fund with which to take care of such roads after they are built. There should be a definite relation between your construction and your maintenance fund. We should never draw on our maintenance fund for construction work. That is being done and has been done in a great many counties. Alamance County issued bonds, but the bill that authorized the bond issue only permitted the commissioners to tax the people of Alamance County for a sum sufficient to pay the interest on the bonds—not one cent allowed for maintenance of the roads constructed. It was not long before they realized they must have some fund with which to maintain the roads, and they borrowed it. That was one of the first cases where county or road commissioners, going on the principle and the decision of the Supreme Court that public roads are public necessities, borrowed the money to maintain their roads. We must not as engineers let our enthusiasm

for construction work get ahead of the practical side of the question of maintenance. We must keep a definite relation between our construction and our maintenance fund. Now if this is taken up at the time a county is discussing the question of issuing bonds and you go before the people, and insist that a clause be inserted in the bill—an amount shall be raised sufficient to maintain the roads—and you explain to the people exactly what that means, you will find that there will be less people against the bill and more for it for the fact that the law provides a maintenance fund with which to take care of the roads.

About five years ago we had a bad winter on roads. We had the cry go up that sand-clay roads were going to pieces. At that time we tried to get information regarding the road, how it was built, its condition before the bad weather and why it went to pieces. We found that a great many of those roads had surfaces of sand-clay or gravel anywhere from four to six inches thick; but the water seeped under and got the clay underneath the sand-clay surface soft and the traffic simply crushed in the surface. You need not expect four, five or six inches of even good sand-clay surface to stand up with nothing under it. It is absolutely essential to the maintenance of roads to be sure that the drainage system is maintained. It would not be very economical or practical in working out a drainage system of roads to put in your culverts two to four times bigger than there is any need of their being, because you expect them to stop up. It is the business of the foreman or superintendent in charge of maintenance to see that they are kept open.

I believe we should put into effect in the various counties in North Carolina a practical system of maintenance so that the roads can be maintained in good condition throughout the year. What is a good practical system of maintenance? What methods have proved satisfactory? I hope in the responses by the engineers and superintendents from the various counties that we can find out what they have been doing or trying to do and in that way we can get information we can use in our own county.

There is one thing that has worked against the method of maintenance; that is, politics. That probably has done more to keep roads from being maintained in winter than any one thing, and it is politics that is taking the maintenance fund and using it for construction work. The idea has been to have built as many miles of road as possible. Many commissioners want to say they have built so many miles of road and the tendency is to take the maintenance fund and use it for construction work and thus be constructing more roads than there are funds with which to maintain them.

A dirt road if built right, with surface free from stumps, can be maintained, I believe, in pretty good condition for travel at a cost of probably one-half what it will take to keep the sand-clay or gravel road in good condition.

I am going to call on the men whose names are on the program and ask them to take up this question of maintenance, and give us their ideas as to what they think would be a good plan to carry out.

Road Maintenance

By W. W. CROSBY, Consulting Engineer.

The importance of the subject of maintenance can hardly be overestimated. I am reminded in a way of a story that I heard the other day about a darkey who had had some funds in a bank. He had been saving a little from time to time, when suddenly the bank failed. The darkey said he had "been hearing

about those things all his life," but he had "never had one to bust right in his face before." Now, the importance of this subject of maintenance has been recognized abroad for a good many years. We hear a great deal about the excellence of foreign roads and we wonder, perhaps, at the explanation of their superiority. I have had the good fortune to be able to make several trips over there to look into road matters and on each occasion have been accompanied by other American engineers. We examined the roads very carefully. We dug into them and asked all sorts of questions, as each one of us had in mind the remarks we had had made to us from time to time by people interested in roads in this country something of this nature: why don't American engineers build as good roads as they have in foreign countries? We felt perhaps a little tender on the subject. We thought we could build as good roads; so, as I say, we went there with the idea of trying to inform ourselves as to why they were better over there. The result of our investigations was the unanimous opinion among all the engineers who went into the subject—and they went into it for the purpose of informing themselves as to the merits of these roads—that the superiority of the foreign roads was simply and solely due to the better maintenance accorded the roads in foreign countries, and I think there is no question but that the apparent superiority of the roads, which you hear frequently referred to by people who go abroad and then come back here and travel over American roads, or by people from abroad who come here and condemn our roads, is due to the better maintenance accorded European roads.

There is another viewpoint, and that is one that should appeal to every American citizen because Americans are especially keen on financial matters. That point is this: that it is absolutely useless, if it is not actually criminal, to put public money into expensive construction and then to let it go to pieces. That sort of thing is not done by the individual. There is not a man who would build a house and put care and money into its construction and then expect that house to keep itself in good condition. You would expect, from the start, to annually average a certain sum of money for the maintenance of that house and you would not start out to make any outlay for construction unless you were sure that in some way you were going to provide the necessary funds for keeping the completed work in good condition and that you were going to see that these funds were properly expended. That has not been the case with the expenditure for public roads until comparatively recently. It has not been the case probably for one or two very apparent but never good reasons. One reason the desirable condition of affairs has not existed is this: there have been so many demands on the road authorities for the improvement of absolutely unimproved roads that they have had no funds, no time, no thought left to give to the maintenance of those roads which have been fairly well improved. Once they made an improvement from available funds, their attention to doing a similar thing was attracted somewhere else and they were obliged by force of circumstances to let those recently improved take care of themselves, at least to a large extent, and to concentrate their time and thought in putting in similar work on other unimproved roads. This is especially true, of course, where the funds are extremely limited and it might be said that a sort of habit has grown up which prevailed even after more liberal funds were provided. This condition of affairs prevailed in my own State of Maryland when the State Aid Fund was first passed and we had ample funds to meet the requests which first reached us for

improved roads according to modern methods. The improvements were made and they were apparently so satisfactory that other localities would demand similar improvements and the old habit of neglecting the earlier improvements, at least temporarily, prevailed during the earlier years to a greater extent than it should have. Later, as the necessity for repairs could not be resisted and the roads could not be neglected any longer, the repairs were made, but the bills were so great as to shock the authorities into considering the question. They soon saw a different form of procedure on some of the newer pieces of road would be much more economical, and that it would be much more satisfactory to accord the new improvements continuous maintenance from the proper viewpoint. The railroads of the country, as far as their physical work goes, are pretty efficient. It is only when matters of high finance creep in that the efficiency, perhaps, as regards results returned for money invested or acquired for investment is questionable. In doing the work, any of you who have had business with the railroads know that they require a fair amount of work for the money paid you for services. How do the railroads maintain their properties? They do not go around once a year. They do not send a gang periodically to repair tracks, but they keep at them every day, and it is only by some similar system that the public roads of the country can be efficiently and properly maintained. It is absolutely useless as I said, and I believe it is in many cases criminal, to borrow money and to build a system of improved roads, with all the expense, with all the thought, time and money required for satisfactory results, unless some proper arrangement for taking care of the completed roads is made from the start. On an average it probably requires about five per cent, more or less, according to local conditions, of the cost of the road annually for its maintenance. It will run between three and ten per cent, according to traffic and the character of the construction, efficiency of construction, etc. I mention this point because I know a great many of you will be consulted and a great many of you will use your influence with the lawmaking authorities in favor of better roads even though you may, perhaps, have nothing to do with the actual expenditure of the money afterwards. On the other hand, some of you will be connected with the movement from the propaganda clear through to the maintenance end of the work, and you must use your efforts from the beginning to see that proper provisions are made, both financially and otherwise, for the maintenance of the results after the work shall have been completed. The borrowed funds of the community can be regarded as its capital and the receipts from the taxes as its income. The capital, the borrowed money, should not be spent in any case to pay annual expenses. The capital should be reserved for investment as far as practicable. That is, capital or borrowed funds should be put into the permanent features of the construction just as far as it is possible to make them go and as a general principle the annual expenditures should be made from the income of the community, that is, from the annual receipts of the tax levy.

Occasionally I have seen communities where borrowed money was used for both construction and maintenance. I think it is the rankest kind of finance to use borrowed money for any purpose except permanent improvements. A continuance of that sort of thing would lead to bankruptcy.

To a considerable extent the details of construction work have been allowed to interfere with the proper maintenance of roads. Construction work is more interesting and has more or less of the spectacular in it. Maintenance work

is drudgery, compared with construction work. Maintenance work is the constant, steady performance of little things, the unremitting attention to details, and after a while it gets very monotonous. On the other hand, any form of construction appeals to the average man from childhood up. It is a very natural thing for the problems of construction to attract more attention than the problems of maintenance; consequently, in an organization where the men in it have both construction and maintenance to look after, the tendency is to have the maintenance neglected and have the bulk of attention given to construction features. That is one reason in some cases, at least, why maintenance has been neglected.

As a matter of fact, most of the construction problems really proceed from the basis of maintenance problems. For instance, in figuring on the size of a culvert, probably the controlling factor in determining that size is the factor of the proper and economical maintenance of that culvert. If made too small, it cannot be maintained. It will be washed out. In designing or selecting the character of surfacing for a road, one kind is selected from the others because, under the traffic and local conditions, it will be more cheaply and satisfactorily maintained. You see, the maintenance idea comes right in at the beginning when you are planning for the construction itself. Of course, the first cost comes in also, but the point I want to make is that the maintenance problem really begins before the construction has commenced and not after the construction is finished.

The first problems of maintenance are probably on any kind of a road the proper maintenance of the waterways and the drainage structures, because unless these are properly maintained it will be impossible to maintain the surfacing or other features of the highway. Frequently, however, little acts promptly and properly performed will prevent serious damage. For instance, if a ditch becomes clogged during a storm by a branch or bush falling down into it and somebody comes along shortly after and removes that obstruction, a serious washout in the roadway may be avoided. That is especially true where the roadway is unpaved or surfaced only with a fairly weak road-crust and where there are considerable banks of earth exposed on the other side. A little stream of water may get started in the wrong direction across a road or along a shoulder of the road, and if some one happens to correct it while small, a serious bill for repairs may be prevented. It is very important that the waterways be kept open and the drainage unobstructed. I remember this subject was being discussed, I think, in Chicago, and Mr. Cooley, State Highway Commissioner of Minnesota, was there. In some parts of Minnesota there are long stretches of flat country and the need of under-drains is very frequent. They use three or four-inch pipe in carrying the water in underground drains. Similar conditions occur down on the eastern shore of Maryland and a county road engineer was present from Maryland. After Mr. Cooley had finished speaking, the Maryland man put this question to Mr. Cooley: "Down our way we have great difficulty in keeping the muskrats out of the under-drains. They get in and stop up the drains. I would like to ask Mr. Cooley if he can suggest any remedy for that condition of affairs." Mr. Cooley said they had had a similar condition in Minnesota, and had found that by putting hollow logs alongside the tile of the under-drain, which was exposed at the entrance, the muskrat would enter the hollow log rather than the under-drain and leave the drain alone. Now that illustrates, perhaps, the ingenuity required of a good man on the maintenance end of the work. In

many cases he can save great expense by very simple expedients. It was probably a very cheap way of avoiding the muskrat. Incidentally, I suppose, they made money out of the muskrat skins and helped pay expenses. Persistence, ingenuity and ability to overcome difficulties in an economical sort of way are what is required of a maintenance man.

Incidental to the question of drainage comes the question of keeping the water out of the roadway itself. Earth roads should be shaped up like a roof to shed water and unless the earth road is kept in this condition, water accumulating on it will soak into the roadbed and very quickly make the road difficult to travel over. About the only thing that can be done to an earth road short of surfacing it is to keep the surface of the road in as good condition to shed water as possible. That, of course, is most effectively done by the log drag. If an earth road is kept in proper condition to shed water—that is, kept crowned up and smooth, and that work done frequently enough—it is possible under average conditions to keep the roadway from becoming saturated with water to an extent that will be seriously objectionable. The surface may become slightly muddy, but the proper and persistent use of the road drag, together with constant vigilance, such as, for instance, the filling of a hole where a slump may occur for one reason or another, will keep the earth road in a very satisfactory condition.

With a sand-clay road there is a slight roof in the shape of a sand-clay mixture placed over the earth foundation and so much help has been given the maintenance authorities toward the protection of the road, but it is still necessary to maintain that roof, and I might say here it is necessary to keep any roof as impervious to water as possible if good results are to be expected. It is the water getting in one way or another that does the damage in ninety-nine cases out of one hundred. The log drag is the instrument for use in the maintenance of a sand-clay road.

A sand-clay road cannot be built in what might be called one period. That is, you cannot go in and build a satisfactory sand-clay road in a short period of time and expect it to be and stay entirely satisfactory. The most successful results are obtained by constant attention to the sand-clay surfacing for a period extending over several years, so as to bring in opposite kinds of seasons during the construction and bring them in more than once. The mixing of the sand and clay is probably best done in most cases by the hoofs of horses and the wheels of vehicles, and it takes time for that to be accomplished fully. You can aid them to some extent by mixing when the road is under construction, but after a road has settled down the maintenance for a few years may be regarded as part of the construction. Effective mixing of the sand and clay is desirable and it is only under traffic or maintenance that the defects will be clearly brought out. In wet weather, muddy spots may develop under traffic. That shows the need of more sand. In dry weather loose spots may develop, which show the need of additional clay to these places. The final mixture, with the proper balances between the sand and the clay can best be had by proper maintenance over a long period. You must keep the surface of the sand-clay road as smooth as possible to shed water. In adding sand or clay it is desirable to add sand in the fall of the year and clay in the spring of the year, as far as a general rule of the kind can be applicable to the needs as they crop out. Keep in mind if the road is inclined to be a little bit muddy in the spring, that it will be better to delay putting any sand on the road until fall and vice versa. The excellence of the results will justify a little inconvenience in the meantime.

Gravel roadways may be said to be the next step toward a highway with a more enduring surfacing over the sub-grade, and the drag is again useful with gravel roadways. However, as the roof or roadway becomes harder and firmer as we progress toward the pavements, the drag alone loses some of its effect and its use may have to be supplemented by picks or steel tools of a like character. The shod drag, that is, a drag with a piece of wagon tire along the edge of the log, will of course be more effective on hard surfacing than the unshod drag. With a gravel road, the maintenance procedure has to be between the procedure in the case of a sand-clay and that of a macadam.

Properly constructed water-bound macadam will show, perhaps, two tendencies. One great tendency is for it to ravel. This may occur in dry weather on any road, and it is especially noticeable where there is much automobile traffic. The automobile sweeps the fine material forming the binder, and protecting the road against the loosening of the stones to some extent, from the surface, and the stones begin to ravel. As soon as stones get loose, the road begins to lose its impervious character, and begins to be susceptible to penetration by water, which is what you do not want. One way to prevent the ravelling of macadam, and a very effective way where there is too much automobile travel, is to simply cover the road lightly from time to time as may be necessary with sand. A very thin coating, perhaps one-eighth to one-fourth of an inch, will give astonishing results in helping to protect the macadam and to prevent it from ravelling. If, however, the objection to dust is too great, or if the automobile traffic is too heavy for a simple expedient like the one mentioned, generally the only thing that can be done is to apply some form of bituminous material, ordinarily known as "oil," to the top of the road. If the "oil" is of an asphaltic character and contains a fair amount of what is ordinarily known as "asphalt," the application of the oil to the macadam does two things: It penetrates between the stones somewhat, in many cases helping bind the stone together; also it helps make the road-crust impervious to water and, with the fine material on the surface of the macadam, forms a carpet which itself will take the wear instead of allowing the wear on the macadam.

That brings us to the bituminous surface, which is now generally known to be a thin layer of bituminous material incorporated with fine mineral material, such as stone, dust or sand, generally mixed under the traffic, and forming a sort of "carpet" or "mat" or "blanket" over the macadam stones themselves, like a linoleum or oilcloth on the wooden floor. Just so long as that carpet is kept in good condition, there is little, if any, wear on the macadam underneath, and the whole problem with the bituminous carpet becomes that of keeping it in good condition in all places. Certain bituminous materials form quite lasting carpets when mixed with sand or stone. Others last for a little while and then the carpet disintegrates, so that it is desirable to select bituminous materials, as far as you can, which will remain coherent as long as possible under the local conditions.

The next problem with bituminous carpets is that of keeping the carpet in place, as a very common tendency of bituminous carpets is to peel off under certain conditions. They sometimes peel off in wet weather in spots of a size varying from that of the palm of one's hand to that of the top of a table. Again they sometimes peel off without apparent cause. If a hole does form in the carpet and the repair of that hole is neglected, it is astonishing with what rapidity the wear will take place. Wear seems to take place then in the

macadam beneath a great deal faster than it would if there were no carpet on the road. The remedy is to repair the small places as fast as they appear and it is most important that this should be done for the sake of satisfaction and economy

I have spoken a good deal about the necessity for promptness in making repairs. Two systems of maintenance have been more or less distinguished from each other, and arguments are made by different parties for one or the other. One system is known familiarly as the "patrol" system, and the other as the "gang" system. It is, of course, entirely possible that the local conditions of any case will demand the selection of one system instead of the other, but from my experience I believe that ordinarily the "patrol" system gives very much better results than the "gang" system. In any event, I think that the patrol system is at the bottom of, or underlies the gang system. I have already instanced the system of the maintenance of the railways. They may have "repair gangs" but under and behind their "gangs" are "patrols" in the form of track-walkers or individuals from the section-gang that are attending to such work. In the same way, in the repair of county highways and of State roads, and for reasons already mentioned, such as promptness, I think we cannot get away from the patrolman. If the patrolman's work is properly done, there is far less necessity for gang repairs and they will be needed with much less frequency than if the patrolman is not kept and if the little things have not been prevented from getting to be big things. In any "gang" system the visits of the gangs must be intermittent. They cannot be made every day. Between the visits of the gang there will be a number of little things which should and can be attended to by a patrolman, and if attended to, will avoid the necessity of a visit from the gang. It is true that in the course of time, even under the patrol system, the amount of work to be done necessary to put the road in good condition again will quite likely require more than the labor of the patrolman, the doing of which will prevent the necessity for larger things. I have never seen a case where the work of the patrolman would not have been a good thing to have had. I have seen a great many cases where if a patrolman had been employed and he had been anything like efficient, the expenses of maintenance would have been greatly reduced and the necessity for gang repairs would have been avoided to a large degree.

There is one set of conditions under which a gang system of repair may have more to support it than any other, and that is where convicts are worked on the road. It is not always practical to work convicts as patrolmen. That has been done successfully, however, in some cases. Ordinarily they are worked in gangs and in those cases the arguments for the gang methods are considerably stronger than they are where free labor is employed.

The problems of construction will probably continue to be presented for a considerable period yet. We have a great many miles of road yet to build even in the states where millions have been expended for road construction in the last ten years, but on the maintenance problems we are already behind. We have to catch up. These maintenance problems certainly will increase, not only as often as construction problems do but also even faster because of the changing conditions of traffic and because of the development of new materials, new machinery and other things affecting their solution. I am quite sure that such a progressive body as this will be able to appreciate the importance of attention to maintenance as well as to construction problems and that you will solve your own problems probably better than an out-

sider could tell you how to do them, but if the experience of an outsider, such as I may call myself for the moment, is of any value, I am only glad to give it to you.

DISCUSSION.

Question: How about the road from Durham here? What would you do with the old worn-out macadam?

MR. CROSBY.—I did not come over that road, but I may say we have had that problem in Maryland to a considerable extent. We have a good many miles of turnpike there and in a way they may be called "old worn-out macadam." We resurfaced some of these very successfully and at a fairly reasonable cost by simply loosening up lightly the old surface with a scarifier, adding the new crushed stone necessary for the proper shape and surface and rebinding the macadam. In some cases the old stone was sufficiently thick to stand loosening up to a greater extent. In such cases we loosened up to a depth of six or eight inches, and in doing so we brought to the surface large stone, together with a lot of finer material. The large material we broke up with hammers; then we harrowed the loose stone so as to shake the fine material down below the surface; then we shaped the roadway and rolled the stone down, binding it with the aid of sand or stone chips and water. Thus we produced a very fair macadam. In some cases, however, we had to abandon the old roadway altogether because the location and grades were not right.

Question: Are you an advocate of mixing sand-clay roads both by dry and wet processes?

MR. CROSBY.—I should do it with both methods as well as I could. I put more confidence and faith in the final mixing by traffic, and subsequent maintenance with the harrow and drag.

Question: What type of harrow do you use in mixing?

MR. CROSBY.—Ordinarily a spike-tooth harrow, which is a little easier to draw around and works better with light teams. I do not, however, know that it has any particular advantage.

Question: Does it give any more thorough mixing than the disk?

MR. CROSBY.—I think to a certain extent it would, in that it is a finer tool than the other. The disk harrow, I think, is more likely to leave lumps of clay with sand around it than the spike harrow does. I think the spike harrow very likely can be depended upon to break up clay better than the disk harrow.

MR. HUGHES.—I do not claim to know much about the proposition, but I agree with you on the proposition that both should be used and then some on that proposition of harrowing. I had one last year that I considered the best one I ever ran up against, a 24 disk harrow, 12 on the front and 12 on the rear, the first cutting out and the rear cutting in. On first sight it looked like a pretty expensive proposition to run it because it takes four good, stout mules to pull it, but it covers so much space you rarely have to run it long. I think it has a base of seventy feet, and is one of the most complete mixing machines I ever saw. In addition to that I always use a spike-tooth harrow and then some. If two harrows can be used, you get much better results. As to a choice between the two, I would recommend the disk harrow, followed by the spike-tooth, but if you cannot get but one, I would take the spike-tooth.

Question: Have you had any experience with glutrin on sand-clay roads?

MR. CROSBY.—I have used glutrin in a number of forms. In some cases it

has not been economical, although it has done exactly what we wanted it to do. As regards sand-clay or gravel roads, glutrin will considerably add to the binding qualities of certain kinds of clay which may be found available for sand-clay roads or may be present in gravel.

Ordinarily these clays either in the gravel or by themselves would not give satisfactory binding results, but if they are used with the gravel or with the clay, to make the mixture, with the addition of glutrin, they will give entirely satisfactory results. It seems to have an action on the clay which increases its elasticity; and in the following spring when wet weather conditions first begin, a rather sticky condition of the surface will have to be looked out for, because it puts the road in a tender condition. It is very likely to be damaged by traffic. The remedy, of course, is to spread some sand over it, but if your maintenance organization is not sufficient to take care of that tender condition of the road, there may be some danger of using glutrin too late in the year. If used early in the year, that condition will not appear in most cases.

Question: What do you think of bituminous materials for sand-clay roads?

MR. CROSBY.—I have had no experience with them. I do not see why they should not be used under some conditions. Under other conditions I should hesitate to use them. I might explain by showing that bituminous material and sand will mix together and form a carpet very satisfactorily, but bituminous materials and clay or finely divided material similar to clay form a combination which in wet weather is likely to turn into a disagreeable, black, greasy mud. Now it will depend on the sandiness or clayeyness of the road as well as upon the character of the bituminous material as to whether the use of the bituminous material and sand-clay mixture can or cannot be properly made.

Question: Do you think where you have a concrete base something like sheet asphalt, that it pays to put concrete back, using cement, or clean rock and then put bitumen back?

MR. CROSBY.—If I had a concrete base in the first place, and it was broken all the way through, I should put concrete back every time, as it will hold better.

There is one important thing to remember in connection with road construction, and that is, providing for a system of maintenance. I did not bring it out because it applies to the construction end. That is, the greater uniformity you can secure in the road course, the better road you have. Now if you can get an absolutely uniform surface, both as to thickness and proportion and size, quality and fineness of surface, the greater the uniformity of wear that will be had on that surface, and the greater the uniformity of wear, it is evident, the less need of repair to the road. If there happens to be a little soft spot in a macadam road, that will wear out and you will have a bad place formed; whereas if it is uniformly surfaced, the whole thing would wear down uniformly and you would have no repairs theoretically until you have worn the whole surface thin. In my judgment, I should very much prefer to have that concrete base restored so as to get uniformity back again into the surface.

THURSDAY AFTERNOON.

Bridges and Culverts

DR. PRATT: Mr. Fleming, of the Newport Culvert Company, will open the discussion this afternoon in connection with culverts. There

are four types of culvert—terra cotta, concrete, cast iron, and corrugated metal culverts. I do not believe any of us is in a position at the present to say what one type of culvert can replace all others all the time. There may be a place for each and the use of any certain kind will very often depend on location and road conditions under which the culvert is to be used.

GENERAL DISCUSSION.

MR. FLEMING.—I feel rather out of place here talking about culverts, because I am not a practical road or culvert man. I know that a culvert is a ring with a hole in it that you stick under the ground and let the water run through, and that lets me out. But I am here to discuss the quality of metal that enters into the construction of metal culverts. Now there seems to be some misapprehension on the part of a few road builders that a metal culvert is a sort of a transient thing and that in the course of a few years it rusts out and you will have to replace it.

In the first place, we have our idea of sheet metal rusting; we have conceived it entirely through experiments with thin sheets. Up to about ten or fifteen years ago, road people were raising such a howl about the rusting of steel that the steel companies began to all wake up and try to find out what was wrong with the steel; so, since that time we have had several big concerns greatly improve the quality of the material entering into their sheets. Now, I might say, the condemning of steel has come about particularly through the employment of very light sheets. The consumer, as you all know, wants something cheap. He orders the lightest kind of a sheet, and expects it to last a lifetime. He orders a 28 gauge sheet and the manufacturer has perhaps given him a 30-gauge; in other words, he has swindled him. Now a 30-gauge sheet is entirely too thin, and it is no wonder that any kind of material would fail without any more body than that.

When we come to the subject of metal culverts, we are still handling sheet iron, but sheet iron with body to it. For instance, 16-gauge sheet which I think is the kind usually put into culverts, is 1-32 of an inch thick. Now there is considerable body to that sheet. When a heavy gauged metal begins to rust, some people might think it is only a question of a very short time till it is going to rust through. I have had one occasion here not very long ago to notice that in connection with culverts. One of our customers or somebody returned to our plant a piece of steel culvert about six inches square that had rust spots on it; the spelter was gone and that person claimed that that material had begun to decay and that it was absolutely useless. Now he was borrowing trouble before it arrived. He simply did not know the condition or what was going to take place in that culvert in the future. It was a 12-gauge culvert with lots of body to it. I cleaned it out thoroughly and it measured .001 of an inch. Now that culvert, I know, would not have eaten through there in a long time. There would not be a hole in more than twenty years, because the metal was so thick that when corrosion takes place it sloughs off a little, but there is still a lot of the sheet left.

The steel companies in advertising a slow rusting material have been guided by what we call the electrolytic theory of erosion. In brief, a theory that says iron rusts because it passes into solution with water that gets on it and that solution corrodes or forms an electrolyte; an electric current flows through that and causes rusting. We have worked along that basis and made

a great improvement in the quality of these sheets. We have eliminated an excess of sulphur or phosphorus or manganese from common steel which is detrimental. When these elements are eliminated we have a material that is unquestionably better than the steel which contains it; but in our clays we have found out through repeated and costly experiments that the pure iron has not gone far enough. There is a step further. For instance, if we could sell a material with 4 per cent of nickel in it to the consumers of culverts, we would make that sort of material and I believe it would outlast a 12-gauge culvert. But to come down to material that is marketable, that we can sell for a price that would justify us making it, we found that a small addition of copper retards its corrosion. Now there has been a great deal of talk about this copper proposition in metal culverts; some of the enemies of copper claiming that it is an impurity.

Now, gentlemen, copper, if it is an impurity, is a costly impurity for our company. We manufacture pure iron containing no copper, and we deliberately put in a certain percentage of copper when copper is fourteen cents a pound. Now we always have and always will find this idea or scheme of trying to call something we put in there to give virtue to the material, an impurity. This is a peculiar situation. There are four or five reputable companies making good metal culverts. Yet all five of these companies (there may be six, but I consider there are only four), if you will ask each one of these companies which is the best, they will say that theirs is the best. They will cite costly and expensive tests proving their statements. Then somebody is wrong. Who is it? That is the thing.

The American Society for Testing Materials, containing over two thousand of the leading scientific men of our country, have appointed a committee of thirty men, of which I am a member, to carry on unbiased corrosion tests. We are going to put on six hundred sheets made all over the country of different brands in three different places in the country. The results of that test will tell which one of those four of five companies is telling the truth and the four or five who are lying.

I represent one of the companies who say they are carrying on corrosion tests. There is absolutely no question in my mind as to how this test is going to come out. In two-thirds of the cases the copper iron was decidedly the best and at the end of the time when one-half of the material had absolutely failed, our material contained absolutely no holes. Out of about twenty-three cases tested, or something like that, our material was the last to have holes clear through the sheet. Now, whether I am telling you the truth or not you do not know, but you can wait five or six years and find out from the reports.

Dr. Walker, the other day in New York, at a meeting of the Industrial Chemists Society, made the statement that the greatest advance made in recent years in the manufacture of steel was in finding out that the addition of a small amount of copper to the metal greatly retarded corrosion.

As far as the durability of metal culverts is concerned, I am free to say that I believe that any of our well-made culverts by reputable steel and iron concerns will give excellent service and I do not believe you have anything to fear through the short life of a metal culvert compared with other culverts. The situation is that there are a great many experiments to be tried and that there is still room for many different ideas and it is quite natural that all people should not agree on it. It is difficult to look over the experiments

that have already been tried and to get them lined up so that you can form any one opinion from them. Testing these materials is part of my business. I was interested the other day in reading where certain railroads had turned over a set of samples for experiment to the University of Illinois to be tried out impartially as to their durability. Some of the metals contained copper, some did not; and when these experiments were finished in many cases the copper showed a much greater durability. The experimenters from the college immediately wrote to the people and asked them why they had allowed this impurity to come in, and the people frankly explained that they had been to a great deal of expense to put it in to prevent rusting. A long time weather test showed that it was so. Now we have another experiment by Chapman, Chief Engineer of the Westinghouse Electric Company, of New York, who exposed two sheets of metal, one composed of pure iron and the other of ordinary steel. He clipped pieces from those sheets and placed them in sulphuric acid for a few hours. At the end of the time the pure iron sheet was practically perfect, and the steel sheet was all to pieces. After one year he was very much surprised to find the steel sheet was the better of the two. There is a great deal about metal admixtures that we do not know yet.

Question: Is it true that either pure iron or iron and copper corrodes more rapidly under the influence of dry or wet weather?

Mr. Fleming's talk brought out a point in regard to the effects of weather and the thickness of iron. There is at the present time some dispute as to how rapidly iron rust can extend into a bar or mass of iron. There is a difference of opinion. Some had an idea that after the rust once starts and the mass of iron is coated with rust, that the rusting process was going on very, very slowly by the protection of iron by the coating of rust; but as it was cleaned off, it began to go on still more rapidly.

Mr. FALLIS.—Now the question has been advanced that the reason we could use this grade of iron in making culverts was that we had a particular type of iron, an open hearth iron, a nearly pure metallic iron, and that it resists corrosion better than the other forms of iron or steel. An experiment I would like to see made is that culverts made of such iron—nearly pure iron known as open hearth iron—be put in the ground and kept there without any coating at all to see the action of the chemicals contained in the ground which come in contact with the outside of the culvert and the water passing through and the action of the atmosphere on the inside of the culvert. More stress, however, is laid upon the covering of the culvert. If you take ordinary steel and coat it with spelter, the spelter is very apt to peel or blister, and when tapped it will come off. That raises the question to my mind, how can we, in regard to corrugated metallic culverts, consider the spelter as making the main value of the culvert?

Mr. FLEMING.—Two factors, atmospheric conditions and conditions brought about by whatever action the earth itself might have upon the outside of the culvert, and the atmosphere on the inside.

Mr. PRATT.—We have not used to any great extent the cast iron. I made the statement that, personally, I believed it would be better to use one particular kind of culvert in a particular place more advantageously. For instance, you take in the western part of the State where you are constructing a road some distance from a railroad point, and to reach this road you have to go over a very bad, rough road. I want to use a pipe of considerable diameter. Is it cheaper and better to haul the terra cotta pipe and put that in than it is

to buy the corrugated iron? We have used the corrugated iron in certain sections of North Carolina and it reached its destination in good shape. Other engineers report that certain corrugated iron they used crushed; while others report that theirs held up under embankments and showed no tendency to break. We do know that in laying the terra cotta we must be careful about how the earth comes in contact with it. With the corrugated iron we are supposed to be able to use that practically flush with the road surface if we wish.

REPRESENTATIVE FROM POMONA TERRA COTTA COMPANY.—There is a certain percentage of terra cotta pipe that is apt to break during burning of the pipe, before it comes out to be put into the distributing rooms. A pipe which is cracked does not ring. There was never any formula for pipe. The American Society for Testing Materials last year at its meeting in Atlantic City, adopted a standard of specifications for such pipe, and some excellent work has been done by an engineer of the College of Iowa, who worked up some tables, and that today is the only correct mathematical data that we have on it.

MR. GALVIN OF THE CAROLINA METAL PRODUCTS COMPANY.—I believe there are a lot of engineers who buy pipe like we poor folks buy furniture, knowing very little about what we are purchasing. From my experience there is a vast difference in the steel and iron. As to which is right and which is wrong is another question. There ought to be some specifications drawn up by engineers which they themselves believe to be right and which the manufacturers can follow. It is wrong to invite culvert manufacturers to bid on any particular number of feet of culvert, not specifying gauges or quality of material. I would say, as a manufacturer, that you would relieve us of a wonderful lot of trouble if you could and would draw up a set of specifications that you yourselves think should be adhered to. We assure you that we will ship you the materials under the specifications that you give us. That is the only way to conduct any business; have something to follow and do not permit everybody to run along and express his opinion and argue the question out. I recommend to you engineers that you draw up a set of specifications, mentioning gauge, chemical analysis, if necessary, or aggregate of total, and then those that get in on that specification, get in on it and those that cannot, stay out.

My only advice as a manufacturer would be to get up a set of specifications, follow it and insist that those who bid on it put up a guarantee that they deliver the material under these specifications.

I might say that it is questionable as to which is the best culvert. I do not believe that any of you engineers can relate any special instance where a guaranteed metal culvert has gone to the bad unless under some strange conditions. They are sold all over the United States and they give real good service.

Terra Cotta Culverts

Digest of Remarks by BENJAMIN BROOKS, Representative of the International Clay Products Bureau.

The road culvert has never received the engineering attention which it deserves, although it is absolutely the only part of a road which can be called thoroughly permanent and which would, therefore, deserve the greatest pains to make it so. It has too often been turned over to the entire discretion of men not versed in engineering and has, therefore, suffered accordingly. While almost any county engineer's office will be full of plans of bridges, no

standard culvert designs can be found among the drawings. This is partly because to hire an engineer to design a culvert would cost more than the culvert.

To meet this difficulty it is a very easy matter to employ one engineer to design a standard culvert, indicating the general method of construction and giving detailed dimensions in terms of the diameter of the pipe, so that, no matter what the size or location of the culvert within certain wide limits, the same standard plan can be used and the same good results can be obtained as in the design and construction of large bridges.

The United States Office of Public Roads has repeatedly called attention to the futility of building culverts without head walls; and no matter what material the culvert is build of this standard design should include very adequate head walls.

The United States Office of Public Roads has also called attention to the futility of a culvert unless the ditches leading to it are kept clean and the weeds cleared from its ends, so as to allow the free passage of water. One reason for giving the head wall ample length is to insure that the earth, falling from both ends on a slope of $1\frac{1}{2}$ to 1, shall not fall far enough to clog the pipe.

This precaution against the stoppage of culverts brings up a point greatly in favor of building them of vitrified clay pipe. Measurements taken on long lines of vitrified clay drain tile in Iowa under the direction of the Iowa State College of Agriculture and Mechanic Arts, indicate that the coefficient of friction as applied to Kutter's formula is not greater than .011, while on the other hand measurements taken with great care on the corrugated metal temporary outfall sewer at El Paso indicate the coefficient of friction for corrugated surfaces is .022. Applying these different coefficients of friction to a 24-inch culvert on a one per cent grade shows that when a culvert is running about one-quarter full—in other words during the period when silt is likely to occur—the velocity of the water through the smooth-bore vitrified clay pipe culvert is about six feet per second, whereas through the corrugated pipe it is only 2.4 feet per second.

In order to illustrate my point about the standard design of culvert and to draw the attention of road engineers in that direction, I have prepared a set of drawings and tables on this plan, copies of which will gladly be forwarded to any one addressing the International Clay Products Bureau, Kansas City, Mo.; and at the same time, in order to increase the interest in this type of culvert and to call to mind the superior characteristics of vitrified clay pipe for this purpose, I have presented a few photographs showing the manufacture of the pipe—not as it was formerly made in North Carolina, but as it is now made, starting with the hardest kind of shale instead of mere surface clay, and using the most modern type of machinery.

The shale, having reached the factory by railroad, is carried by belt conveyors to what is known as the dry mills, these being horizontal circular perforated tables of metal revolving under heavy steel-shod rollers. As the material is reduced to the fineness of sand by these rollers it passes down through the perforations and is next conveyed to storage bins and sifted, that material which is rejected by the sieves being returned to the rollers to be ground again. The sifted or screened material then passes to the wet pans or wet mills and is there mixed or kneaded with water under a similar system of heavy rollers until it is of the consistency of very stiff putty. In this state

it goes to the press, which is a combination of two cylinders one above the other, each with a piston connected by a long piston rod. The upper cylinder receives steam from the boilers above the piston, the lower cylinder receives clay below the piston.

Since the upper piston is several times larger than the lower one, many times the steam pressure is exerted on the clay. This great pressure compels it to take the shape of the socket of the pipe, and when the bottom part of the clay cylinder is removed the pressure from above forces out the clay just as macaroni is forced from the press, and the parallel barrel part of the pipe is thus formed.

The drying of the pipe is not left to a matter of chance or weather, but is conducted in large rooms with slatted floors under which an extensive network of steam pipes maintains an even temperature day and night the year around. Having been dried to hardness in the course of five or six days, the pipes are then stored in stacks in circular brick kilns and fires applied to them through six or eight openings around the circumference of the kilns in such a way that the flame does not play directly on the pipes but is deflected to the domed roof of the kiln, from which the heat is reflected down evenly upon them. The increase in temperature is very gradual for the first few days and finally reaches 2,000 degrees F. At this temperature all the inflammable or perishable ingredients of the clay have been burned away, leaving only that which is indestructible. This indestructible part is reduced by vitrification or melting to the condition of maximum density, making it impervious to water or any destructive agency from without.

This "trial by fire" largely accounts for the extremely long life of vitrified clay pipe in service and enables us to show photographs of pipe made as long ago as 7,000 years by Egyptian engineers. As a finishing touch to the pipe, salt is thrown into the fires when the vitrification has reached the proper point, and this salt combines with the clay in such a way as to cover the outer surface of the pipes with a thin layer of glass. It remains then but to allow the pipes to cool gradually and to crate them up securely in cars for shipment.

The following copies of specifications for corrugated metal pipe and proposed bid for corrugated galvanized culverts were distributed to the institute:

United States Government Specifications for Corrugated Metal Pipe

Corrugated metal pipe shall be made from metal of not less than sixteen (16) United States Standard Gauge for pipe having a diameter of 20 inches or less and not less than fourteen (14) United States Standard Gauge for pipe between 20 inches and 36 inches in diameter.

The metal shall carry not less than two ounces of prime spelter per square foot, uniformly distributed. The coating shall be of such nature that it will not peel off, and any bare or uncoated spots shall constitute a sufficient cause for rejection.

The joints shall fit evenly and close, and the jointed pipe shall be straight, circular in section, true and rigid.

All rivets used in the fabrication of the culvert pipe shall be of the same quality of metal as the pipe, thoroughly galvanized, and shall be not less than one-fourth inch in diameter for sixteen (16) gauge pipe, nor less than three-eighths inch in diameter for fourteen (14) gauge pipe.

Longitudinal joints shall have rivets driven in the valley of each corrugation and the rivets shall be spaced not more than 6 inches apart in transverse joints. The rivets shall be driven in such a manner that the sheets are drawn tightly together, so that they will completely fill the holes in the sheets and will have neat, workmanlike semispherical heads and shall be at least one inch from the edges of the sheets.

Field joints shall consist of bands not less than 8 inches in width. These bands shall be made from the same material as the pipe and shall be properly fitted with malleable cast iron lugs, provided with bolts not less than $\frac{3}{8}$ inch in diameter, in such manner that a secure and firm connection may be made.

Corrugated Iron Culvert Specifications

MATERIAL:—(a) The metal composing the Corrugated Pipe shall show an iron content determined by difference of at least 99.84 per cent pure iron; that is, the base metal shall not show more than .16 of 1 per cent impurities, namely, .11 of 1 per cent in the aggregate of carbon, manganese, phosphorus, sulphur, silicon, oxygen, hydrogen and nitrogen with not over .05 of 1 per cent of copper and must be of uniform and homogenous composition. A variation of not to exceed .02 of 1 per cent in the above mentioned total impurities shall be allowed covering the recognized analytical variations between expert chemists.

(b) All sheets besides being of the analysis as stipulated in the foregoing paragraph, shall be free from blisters, seams, slab or other foreign substances.

(c) All sheets must be of the gauge as represented, subject to the customary allowance of $2\frac{1}{2}$ per cent for variation, as per act of Congress, July 1, 1893.

GALVANIZING:—The metal shall be galvanized by the hot rolling process, the zinc spelter to be of the first quality and not less than two ounces to the exposed surface of one square foot of metal. The metal shall be galvanized before corrugated. Tests for weight of zinc spelter shall be made by the lead acetate method.

CONSTRUCTION:—All pipe shall be riveted and of full circle and with riveted seams and lap joints made tight. The rivets shall be guaranteed of the same analysis as the metal used in the manufacture of the culverts. 5-16" rivets shall be used in all diameters up to 48" inclusive, and $\frac{3}{8}$ " rivets for diameters larger than 48". On all culverts of a diameter under 30", there shall be one rivet in each corrugation and on all culverts 30" in diameter and over, there shall be two rivets in each corrugation. All rivets at circumferential joints shall be placed not more than 8" apart from center to center. Each culvert shall be made in one piece except when too long for economical handling, in which case sections shall be equipped with coupling bands.

TESTS:—Two pieces each not less than 4" square may be cut from any section of pipe so furnished, one to be tested by the purchaser and the other by the manufacturer after galvanizing has been removed. If said pieces are found by the purchaser to contain, contrary to the manufacturer's guarantee, a greater percentage of impurities than called for in the specifications, then a third party, who shall be a Metallurgical Chemist of recognized standing and satisfactory to both the first and second parties shall make a checking test from the two pieces in question. In case he finds the metal to be below specifications, then the consignment may be rejected without obligations by purchaser.

GAUGE OF MATERIALS:—The standard gauge shall be the United States Standard Gauge. (a) For all culverts under 30" in diameter the material shall be No. 16 gauge. (b) For culverts thirty (30) inches in diameter and not over forty-eight (48) inches the material shall be No. 14 gauge. (c) For culverts sixty (60) inches in diameter material shall be No. 12 gauge. For larger sizes than sixty (60) inches in diameter the material shall be No. 10 gauge.

Proposal—Bids for Corrugated Galvanized Culverts

To the of

We,, undersigned, by our authorized agent,, propose to furnish and deliver upon your order, f. o. b., cars, corrugated, galvanized culverts at the following net prices per lineal foot, and in accord with the following specifications and conditions governing manufacture and material:

Diameter.	Gauge.	Price per lineal ft.
10"	16	.....
12"	16	.....
15"	16	.....
18"	16	.....
20"	16	.....
24"	15	.....
30"	15	.....
36"	14	.....
42"	14	.....
48"	14	.....
60"	12	.....
72"	10	.....
84"	10	.....

The base metal composing culvert is known as
and manufactured by the, of
The culverts are manufactured by, of

CONSTRUCTION:—Style of culverts to be knocked down form or set up ready for installation.

Culverts to be riveted in full circle, and in continuous length or lengths, straight and in workmanlike manner.

MEASUREMENTS:—All diameters shall be the measurement on the inside of the culvert from the two closest points.

GAUGE:—All Gauges shall be in accordance with those set opposite the indicated price; United States standard to be recognized and furnished:

RIVETS:—All rivets to be used to be of

Rivets on 30" diameter and over to be inch thickness.

Rivets on 24" diameter and under to be inch thickness.

Rivets on 24" diameter and under to be singly or doubly riveted.

In every corrugation

In every second corrugation

In every fourth corrugation

Riveting to be straight

Riveting to be staggered

Rivets on 30" diameter and over to be singly or double riveted.
 In every corrugation
 In every second corrugation
 In every fourth corrugation
 Riveting to be straight
 Riveting to be staggered
 Circumferential riveting to have rivets not less than
 inches apart.
 Depths of corrugations to be not less than inches.
 Joint laps to be not less than inches.
 Side seams or longitudinal laps to be not less than
 inches.

GALVANIZING to be spelter. Prime Western from virgin ore, or

Spelter to contain at least per cent pure zinc, and not over of iron.

Both sides of each square foot of sheets composing the culvert shall contain at least ounces of spelter.

All sheets to be first class, free from blister or signs of cracking.

BASE MATERIAL:—Base metal composing the culvert shall be not less than per cent pure iron taking into account all foreign substances, gases or metal alloys.

COMPOSITION:—The composition of the base metal shall be:

Carbon
Silicon
Copper
Oxygen
Hydrogen
Phosphorus
Manganese
Sulphur
Pure Iron
Nitrogen

100 per cent.

A good and sufficient surety bond issued by a responsible bonding company shall be furnished, guaranteeing the above analysis, and in default the purchaser shall retain payment until bond is delivered.

The purchaser reserves the right to withhold one-half the total amount of invoice of any orders shipped under these specifications until the tests and chemical analysis, herein designated, have been made; but with the understanding that such tests and analysis are to be made within sixty days from receipt of culvert shipment. Should it be found that the samples taken from the culvert do not come up to the specifications herein indicated as to purity and chemical analysis, the gauge and riveting as specified, balance due shall be forfeited by the company furnishing the culvert under these specifications, and all culvert received to become the property of the purchaser.

Any bidder, bidding under these specifications shall have the right to take the necessary sample from the culvert furnished under this proposal, and have analysis made to see that the material is in accord with the specifications, both as to gauge and material analysis. If any bidder finds that the specifications have not been complied with and so notifies the purchaser in writing

within thirty days after the delivery of the culvert, the purchaser may have the analysis verified by the proper authorities equipped for determinations of gases, and gauge verified by proper United States government department. Should it then be found that the specifications herein set forth have not been complied with, then the penalties hereinbefore described shall be assessed against the bidder furnishing the culvert, and all costs of verifications to be deducted from purchase price of the culvert.

The complaining bidder shall, with his complaint, furnish the purchaser a certified check in amount of one hundred (\$100) dollars to cover cost of analysis and verification, and cost of same to be assessed against the complainant if it is found that specifications as to gauge, riveting and analysis have been complied with.

The purchaser reserves the right to use more or less than the amount indicated in the estimate, at the herein named prices as accepted, provided the amount ordered shall not be less than a car lot quantity of minimum weight, 24,000 pounds.

As a guarantee of good faith and faithful performance of contract awarded on these specifications, a contract will be entered into, and certified check made payable to purchaser to accompany proposal, in amount equal to 25 per cent of the total amount to be purchased at prices herein shown.

Each bidder waives any rights, other than those mentioned in this specification and agrees to be governed by the foregoing.

Respectfully submitted,

By

Dated at, this the day of 19...

Accepted this the day of, 19...

By
.....
.....
.....

Bridges

GENERAL DISCUSSION.

MR. FALLIS.—I am not very well prepared to discuss bridges offhand, except in a very crude way, but many things come to my mind in connection with the general subject of bridges which I think would be well to consider. There are, of course, a good many types of bridges in common use—wood, concrete and steel bridges, and various kinds of trusses, floors, etc., all more or less good, often very much less.

The first thing to do about a bridge is to get the foundation and build the abutments and head walls and piers. There are many classes of material for and kinds of foundations used in the State to a great extent—concrete, cut stone, cement rubble, dry rubble work and steel cylinder piers, and sometime abutments made of steel cylinders are used. The stone masonry bridge foundation has been used in the past to a greater extent than it will be in the future, on account of the popularity and security of concrete. The stone masonry pier or abutment is an economical structure compared to the plain concrete, but is not so easily built, nor so secure as concrete. The concrete foundation is better in every respect, if you get good concrete work, good

sand and cement, and experienced men to build it. I think one of the greatest troubles we have in the State in our construction work is failure to put men on work who know how to do the work they are expected to do. Inefficiency of the man used often causes the failure to get good results, and when he does not get satisfactory results sometimes the method or the material is blamed. Inefficiency is one of the chief troubles we have, and is frequently forced on us in the false guise of economy, and for reasons of political expediency. In the masonry abutment, as in every other abutment, the sub-foundation must be capable of carrying the weight of the abutment to be built, and in addition safely carry the superstructure and service loads. Foundations in all construction, and especially of the larger bridges, should be carefully built. A solid rock sub-foundation should be used whenever possible, or pile foundation built with a proper care for the loading can be used. Concrete piles can be used, and are recommended for such places where solid rock can be found at a depth not exceeding ten or twelve feet, and can be sunk through a rather firm soil to such rock. In using concrete for abutments or piers a large slab of concrete, say three or four feet thick, may be used to cover the pile—place it directly on the piles, and then build the abutment or pier on the slab; and it is not quite so important to have a continuous or solid pier on it, in the case of a pier, and we can distribute the pile heads considerably farther apart under a concrete slab like this than would be possible otherwise, or under any other kind of masonry work. Always be sure, however, that the piling remains wet at all times of the year.

The steel cylinder pier has been used a great deal in the State, but has never proven very satisfactory, and I would condemn the use of such piers without any exception. We can use the concrete pier at practically the same cost, and the stability of the concrete pier at this cost can be made much greater than the cylinder pier, and it is certainly more durable. There are several objections to the steel cylinder pier. The constant wetting and drying of the footing of this pier will soon cause this section of the pier to corrode and weaken. The foundation under a steel cylinder pier is very often insecure, frequently with only two or three piles at most under it, and with only the few square feet of area that it has to be carried on it is hard to get a satisfactory bearing. In some cases even the pressure from the wind brings a considerable weight on one side, and sometimes that comes from one direction much more frequently than another, and all those questions are to be considered. The weakness from inferior workmanship is often great. They are often filled with sand or only a semblance of concrete. In one of the western counties some time ago we took out the concrete cap that the bridge seat was on and found that the contracting bridge company had simply filled the cylinder with sand and put a concrete cap on the top. This pier had only been placed a short distance in the ground, but fortunately it touched the edge of a solid rock on one side. This was not sufficient foundation to support that bridge. Recently a county in the east made a contract for a small draw-bridge, and on visiting the site after three of the piers had been put in, I happened to get the opportunity of seeing the fourth one when placed. The contract called for the driving of four piles under each cylinder, but the contractor had found some old railroad scrap pile and gotten four pieces of 20-pound steel rails about six or eight feet long and had driven three of these under each cylinder in order to take the place of four piles specified. I reported the fact to the commissioners and they telegraphed the contractor

that they would not receive the bridge unless the pile foundations were properly put in.

A short time after that the War Department of the government required that we put fenders to the draw, in order to protect the passage of boats. After driving piles on the upper side of the bridge the foreman on the work put his pile hammer, weighing 2,000 pounds, on or over one of these cylinders and left it there that night. The next morning this cylinder had settled so that the draw would not close. So I do not believe it is good policy to use steel cylinder work at all. A concrete pier can be built at approximately the same cost, using 36" to 48" cylinders, with a 12" web between on a slab base foundation, three to four feet thick, at the average price of six to eight dollars per yard for concrete, using wood forms for this work, and they cost less money than concrete and steel forms for the same size steel cylinders.

In discussing wood bridges, I guess we all agree that the day of the wood bridge has passed. The price of lumber is high, and at best they are uncertain as to their safety; if it has any extended life to it, it must be a covered bridge, and I am satisfied we can approximate the cost of any covered wooden bridge with a steel structure that will give very much better results both in life and safety.

Concrete bridges have a great future in store, and are proper construction in a great many locations, but I would not approve of them in some cases. I believe they should be used wherever the traffic is heavy, as at points close to markets and cities, and wherever the amount and kind of traffic will justify the expense. I believe the concrete bridge should be used wherever the cost of the concrete bridge is low enough to make it a good business proposition. To illustrate: in one of our counties somewhere near \$100,000 was spent for a bridge on a road that has no considerable amount of traffic, and in no way justified this expense. They should have divided this amount up into several good steel bridges or a good steel bridge at this location, and the interest on the money thus saved would have replaced this bridge about every six years, or saved to the county this amount. We can use I-beam bridges over short spans very easily, and very economically. We can buy these I-beams at rolling mills, priced f. o. b. our nearest railroad station, or the bridge companies will furnish them ready for erection. I-beam bridges can be used over longer spans than is usually indicated by the bridge companies' designs. I have used I-beams 15", 42-pound beams on a 40-foot span that did not give too much deflection, and did not have too much vibration, and they were perfectly safe under any load that would ordinarily come over them. They can be built very economically by local labor, under the supervision of the county engineer and the superintendent of road forces in the county. When we have to use the longer span of bridge the steel truss bridge in its various forms should be used. I always use a "pony truss" bridge on spans up to 75 or 80 feet. This on a low truss not running over eight or nine feet high, and has no connecting members between the trusses overhead. By the use of this truss we get rid of the excessive or troublesome upkeep of the higher bridge, so far as painting the high truss and examination is concerned, as this matter, especially the painting, should be looked after carefully. I would use a riveted truss of this length, because it is short and light, and easy to erect, and for that same reason I would rather have a pin truss for all spans over 100 feet, because of the ease and rapidity of the erection, and the difficulty of securing proper field riveting on the higher trusses.

In bridge floors, I believe that the flooring of the bridge, when of wood, should always be of three inch material, and always sized. I think the economy of using a sized floor is a great deal more than people usually consider. It reduces the vibration on the bridge. It makes it more pleasant to drive over, and increases the life of the floor itself. I am sure a three inch floor is more economical than a thinner floor for the reason that we have greater strength in the floor to begin with. We can allow that floor to wear and decay more than a thinner floor before becoming unsafe, and it will last longer. As a safe floor, concrete is very much more desirable as a floor material than wood, and in a few years this floor promises to be as cheap to build as a wooden floor, and the concrete floor has several advantages, I believe, over the wooden floor, which is rapidly becoming more and more expensive. I believe it will tend to preserve the floor joist, because if properly constructed and waterproofed there will be less chance of corrosion under a concrete floor if well built, and it can be made practically water-proof by a bituminous or other coat on top before putting wearing surface on it.

Another point in regard to the painting of the bridges: It is rare that a bridge built under a county commission is properly painted. I inspected a short time ago a bridge painted for a county under a bridge company's instruction, care was not taken in cleaning the rust from the steel and at least two-thirds of the paint came off because of rust being left underneath the paint. We took chisels and hammers, cleaned it off thoroughly and painted it with two coats of good graphite paint, and after that compared the cost of double coat together with the cleaning and the bridge company's charge for their inferior work, and we were still \$100 to the good.

If the counties in the State would all secure competent engineering advice in the construction and maintenance of all road and bridge work in the State, they would save enough money to pay the salaries of all the county officers in the average county of the State.

The following letters, with bridge specifications, were distributed at the institute:

Bridge Specifications and Letters Regarding Same Distributed at Institute

TARBORO, N. C., January 21, 1915.

DR. JOSEPH HYDE PRATT, *Raleigh, N. C.*:

DEAR SIR.—We wish to submit an illustration showing the value of engineering services in bridge work. It became needful to repair the Tarboro bridge in this city. We employed one of the Survey engineers, Mr. W. S. Fallis, to advise us in regard to the matter. After an examination the engineer advised immediate repairs and furnished contractors with needed information to bid on same. The lowest bid was for the sum of \$5,200. The engineer advised that the bid be not accepted and that a competent bridge erector be employed to do the work under his supervision. This our board did and we secured the required repairs in a complete, first-class workmanlike job for the sum of \$2,541.91, saving to our county more than half of the amount that we would have been forced to pay to the bridge company if we had not employed an engineer to advise us in the matter.

We give this information from actual experience, and hope that it will be of service to you in convincing the different boards of county commissioners

in our State that we found it much more satisfactory than letting the work out by contract, as we get better paint and better and more satisfactory work in every way.

Yours most respectfully.

(Signed)

R. B. PETERS,

Ex-Chairman Co. Com. Edgecombe County.

Austin Bros., \$5,300.

Roanoke Bridge Co., \$5,200; without paint, \$4,300.

TARBORO BRIDGES.

Pay rolls	\$86.87	Not in contract.....	\$86.87
Pay rolls	77.24		
Pay rolls	74.84		
Pay rolls	206.15		
Pay rolls	108.50		
Pay rolls	115.75		
Pay rolls	232.65		
O. F. Yornst.....	18.00		
O. F. Yornst.....	25.00		
O. F. Yornst.....	100.97		
	<hr/>		
		\$1,045.97	
Watchmen	\$86.30		
Watchmen	39.65		
	<hr/>		
		125.95	Not in contract..... 125.95
Supplies:			
Tarboro Hdw. Co.....	\$16.53		
T. F. Marrow, Agt. Frt..	72.20		
D. Lichtenstein Co.	1.25		
Marrow-Pitt Hdw. Co. ..	4.00		
Frt. Cement & Rock....	56.01		
Rope Pull	12.90		
Freight	58.35		
Tarboro Hdw. Co.	48.10		
Smith-Courtney Co.....	33.72		
C. P. Lathrop, Rock.....	125.02	Not in contract.....	125.02
L. R. & W. G. Sugg.....	36.18	Not in contract.....	36.18
J. Dixon Crucible Co. ...	128.70		
King Bridge Co.,	463.11		
Tarboro Hdw. Co.	47.47		
Jameson McK. & Evans..	208.36		
S. Courtney & Co.	2.20		
L. R. & W. G. Sugg.....	21.65		
J. Dixon Crucible Co. ...	128.70		
Freight	4.86		
	<hr/>		
		1,472.31	
W. S. Fallis.....	\$62.10		
W. S. Fallis.....	279.20		
	<hr/>		
		341.30	
	<hr/>		
		\$2,985.53	

Lumber, J. E. Harris....	\$104.01		
Lumber, E. T. Warren..	53.39		
Lumber, E. T. Warren..	325.00		
Lumber, E. T. Warren..	180.24		
		\$ 662.64	\$ 662.64
		\$3,648.17	\$1,106.66
		1,092.69	
		\$2,555.48	

\$5,200.00

2,555.48

\$2,644.52 saved.

GEORGE L. AUSTIN, Atlanta, Ga.

FRANK E. AUSTIN, Dallas, Texas.

AUSTIN BROTHERS,
Steel Bridges and Structural Work.

Office and Yards:
Greenwood Avenue and Southern Railway.
Near Ponce DeLeon Springs.

GREENSBORO, N. C., January 28, 1914.

TO HON. BOARD OF COUNTY COMMISSIONERS, *for Edgecombe County N. C.*:

GENTLEMEN.—We will furnish material and labor and put in place the repairs to the steel bridge over Tar River as set out by your engineer for the sum of fifty-three hundred (\$5,300) dollars. Should this proposition be accepted we would require your engineer to go over the bridge with our engineer and make a detail specification as set out in his specification memorandum, and have his O. K. to them before we would sign contract.

Yours truly,

AUSTIN BROTHERS.

(Signed)

By C. W. CURRY, Agent.

ROANOKE, VA., January 24, 1914.

HON. R. B. PETERS, *Chairman Board of Commissioners, Edgecombe County, Tarboro, N. C.*:

DEAR SIR.—We, the Roanoke Bridge Company, Incorporated, Roanoke, Va., propose to furnish and erect all necessary material for repairing the steel drawbridge over Tar River, at Tarboro, N. C., as per specifications prepared by Mr. W. S. Fallis, Civil Engineer, which are attached and made a part of this proposal for the work, as follows:

We hereby propose to furnish and erect complete new bottom chords for the single span. These chords to consist of two lines of 7" channelslaced. Two lines of "I"-beam floor joists, consisting of 7" beams, 15 pounds per lineal foot for each joist throughout the entire length of the bridge. One reinforcing plate 6 x 20' 0" long, to be riveted to the top flange of the 15" floor beams where needed. We hereby propose to furnish and erect the necessary side-walk brackets at the end of the floor beams which will have to be repaired.

We will furnish and erect the material as stated above and as per the specifications by Mr. Fallis attached, for the sum of \$4,800.

We hereby agree to furnish all material and do all necessary work as per above specifications and give the entire structure one new coat of standard bridge paint for the sum of \$5,200.

If awarded the contract for repairing the above bridge, we will commence work within ten days from receipt of order and rush same to as early a completion as possible.

Inasmuch as we have just completed certain repairs for the above bridge, we feel that we are in a position to know just what is needed to repair the old structure and make it safe and solid for future traffic.

Hoping to be favored with this order, we remain,

Yours very truly,

(Signed)

ROANOKE BRIDGE COMPANY, INC.

H. F. GAY, Manager Highway Department.

CURTIS AND THORNTON COMPANY,
Engineers and Contractors Steel Bridges.

HICKORY, N. C., August 18, 1913.

W. S. FALLIS, C. E., *Franklinton, N. C.*:

DEAR SIR.—We propose to furnish and fabricate and deliver at Hickory, N. C., the metal required for the bridge at Brookford, near Hickory, N. C., in accordance with the plan herewith submitted for the sum of \$2,37½ per hundred pounds. Or, will fabricate and deliver all metal required at Hickory for the lump sum of \$1,195.

Respectfully submitted,

(Signed)

CURTIS-THORNTON COMPANY.

R. W. CURTIS.

HICKORY, N. C., February 12, 1915.

DR. JOSEPH HYDE PRATT, *State Geologist, Chapel Hill, N. C.*:

DEAR SIR.—As a member of the Hickory Township Road Commission, I wish to thank you for recommending Mr. W. S. Fallis to us as engineer. We have found him extremely satisfactory in the work he has given us, and in one point particularly he has saved us quite a sum of money. We had an old bridge across the South Fork River to take care of, and found it necessary to raise and widen it. We took the matter up with the representative of a bridge company who has had quite a great deal of experience here in the South, and with Mr. Fallis. After considering the matter, we took the latter's plan and rebuilt the bridge at a saving of \$529 over the best bid (\$1,195) that we had from the bridge company. We think that this itself shows the value of a good engineer to any road commission.

We trust that you will be able to see the State Highway Commission bill go through the Legislature, and give all the counties the benefit of good engineering service.

Very truly yours,

(Signed)

G. H. GEITNER,

Chairman Hickory Township Road Commission.

Use of Explosives in Road Work

By J. H. SQUIRES, Agronomist,

E. I. du Pont de Nemours Powder Company.

When we consider the mileage of road being built or repaired annually in North Carolina and estimate the enormous cost of the work, it at once be-

comes evident that any saving, no matter how small a percentage, on the different jobs will amount to a large sum in the aggregate, sufficient to build a considerable increase or to keep many miles in excellent repair.

Direct savings are resulting in all cases where there is a replacement of hand labor by improved methods, such as suitable machinery and high explosives.

It is the purpose of this paper to give some idea of the different grades of explosives suitable for highway construction and some information regarding their uses. The best results can be obtained only by the selection of the proper grade and strength of explosives and by employing the best known methods of handling and loading.

For general road work the explosives used range from black powder to the strongest dynamite. Black blasting powder has been in use longest; it is chiefly employed for loosening certain classes of tight clays or loose rock and a few still prefer it for rock cuts. It is not water resisting and requires more careful handling than the lower strength of low freezing dynamite, which are rapidly replacing it.

Powders of the Judson type have also been in use for highway construction for a long time. In practical use they are loaded in much the same way as blasting powder, than which they are more water-resisting and faster and more shattering in their action. They are, however, slower and less shattering than dynamite. All of the Judson type powders, now known as low powders, are reasonably low-freezing. When frozen it is necessary to thaw the F, FF and FFF grades, but if the lumps of R. R. P. are thoroughly crumbled in the hand before loading, thawing is unnecessary.

The selection of dynamite for the different classes of highway work permits of the widest variation on account of the various strengths and the characteristic qualities of the different grades. Later, mention will be made of the application of the different strengths and grades.

Some of the principal uses of explosives for highway construction are clearing the right-of-way, ditching the roadbed, loosening soils for reducing grades, excavating cuts and breaking up stone for surfacing material.

In clearing the right-of-way in this State the chief obstacles are stumps. These are now ordinarily removed by hand labor, a slow and expensive method, no matter what kind of labor is used. If it is hired labor the cost is high, and if it is convict labor it is taking up valuable time that might more profitably be used where there is other work requiring hand labor. A cheaper, quicker, more satisfactory method of removing these stumps is by blasting. For this work a low-freezing extra 40 per cent dynamite is usually found more satisfactory except in very loose sandy soils where a quicker acting 50 per cent or 60 per cent straight N. G. dynamite will give better results. In loading the effort should always be to get the stump on the first blast because it is difficult to blow out a stump after it has been shattered by a poor blast. The chief trouble is loading too shallow. The bore hole under a stump should be deep and well under the part offering the greatest resistance, which is usually near the center of the stump. When large stumps are encountered several bore holes should be used so that the charge may be distributed under and around the large roots. When such loading is practiced, electric firing must be used. Often in cuts heavy loading will have the additional advantage of excavating a considerable amount of ground along with the stump and hasten the cut work.

For blasting boulders from the right-of-way it will usually be advantageous to place the charge in a hole punched under, but immediately against the bottom of the boulder. For such loading the explosives advised for stumping will be found to give entire satisfaction. When mudcapping is practiced this low-freezing extra 40 per cent may be used on easily broken stone or where there is little work to do. On the hard nigger-head boulders, most often found in this State, it will be better, especially if there is much of this work to do, to use either 50 per cent or 60 per cent straight dynamite, as the action is more shattering. It should be remembered that straight N. G. dynamite is not low-freezing and should be carefully handled in cold weather.

These two methods of blasting boulders require but little labor, however, the amount of explosives needed is considerably greater than if a hole is drilled into the boulders and the dynamite securely tamped into the bore hole.

In grading, where cuts are made in hard rock, a good all-the-year powder is the low-freezing dynamite mentioned above. When the cut is in loose rock the strength may be anything from 20 per cent to 40 per cent. If it is tight soil from 20 per cent to 30 per cent. In hard rock, 40 per cent is usually preferred.

Much work is now being done in widening cuts in improving old roads. The side slope is usually too steep to use teams, and pick work is expensive. Such side slopes may be loosened and thrown on the old road by blasts of low-freezing 20 per cent dynamite or Farm Powder or Low Powder, F or FF, placed in a line of holes spaced a little way back from the brink of the cut and fired electrically. This will put the soil in good shape at a place from which it can easily be removed with scrapers.

After many miles of country travel, I am convinced that the greatest drawback to country roads today is bad drainage. We need not only a well rounded surface and a pair of side ditches, but also a means of discharging the water from these side ditches. Such discharge or outfall ditches are always at the lowest points and often through swampy or stumpy ground. Former difficulties in ditching such material caused the drainage to be neglected and the roads have suffered as a consequence. The average cost of digging swamp ditches with dynamite has been about 10 cents per cubic yard. The methods are simple and no expensive outlay for equipment is needed. When the work is through wet soils and a large ditch is desired, the best and most satisfactory results are obtained by using 50 per cent or 60 per cent straight N. G. dynamite, detonating an entire line of ditch with a single cap and fuse, depending on the shock from the one primed hole to discharge the rest. When the soil is dry this method will not work, and a lower strength dynamite, preferably low-freezing, is used and detonated electrically. In the first case the bore holes are spaced from 18 inches to 24 inches apart, but in the latter the distance is increased to 24 inches or 32 inches for small ditches and for large ditches may be as great as 48 inches.

The exact limitations of this method of ditching have not as yet been worked out but ditches up to 18 feet wide and 9 feet deep have been economically blasted, although it is not generally advised to undertake ditching deeper than 5 feet or 6 feet. In changing stream courses to protect bottom roads, this method is found to be wonderfully successful in straightening the streams and in removing stumps, rafts and boulders from the channel to permit a freer flow.

In shattering field boulders to get surfacing material the methods of load-

ing and explosives already recommended for clearing the right of way will be found to be the best. Often a temporary or permanent quarry may be opened up to better advantage, in which case the handling of the face will be of material moment in the cost of the stone. The face should be kept as straight and even as possible and it is usually best to have the holes drilled the full depth of the face. For most of the stone in North Carolina a low-freezing extra dynamite of 30 per cent to 50 per cent strength will be found best.

In digging post holes in different classes of soils along the roadside, two methods are employed. In one, a slow low freezing powder is fired in small amounts in the bottom of the hole and the loose soil is shoveled out. In the other small charges of 40 per cent to 60 per cent dynamite are tied to a stick and distributed along the bore hole and fired from a single cap in the top charge. This will be found to force back the soil and reduce cost and time to a minimum. Better results will be obtained if the top of the hole is excavated by hand to a depth of 6 or 8 inches before the blast is fired.

Frequent mention has been made of low freezing explosives, the use of which not only hastens work in frosty weather but gives better results and overcomes the dangers due to careless thawing, because these explosives are frozen only in the coldest weather in this State.

DISCUSSION.

Question: What method do you advise for thawing dynamite?

Answer: For small amounts use only an accepted type of thawing kettle. For larger amounts an unopened case can be buried in green manure the day before the explosive is needed. The heat produced by the fermentation of the manure will be sufficient to thaw the dynamite. Never thaw dynamite around the forge or before fire or in hot ashes or sand.

Question: About how much burden should be taken in blasting out a rock cut?

Answer: For shallow work put the holes back from the face about as many feet as the cut is deep and drill the holes a little below the sub-grade. Space the holes about the same distance apart and load them from one-half to two-thirds full. For cuts deeper than 6 feet the burden and space should not be over 6 or 8 feet. Good tamping is essential.

Question: What about water tamping?

Answer: Water makes excellent tamping in wet work, but is seldom used in dry work, as moist clay makes excellent confining material and has the additional advantage of not wetting the dynamite and detonator.

Question: How would you handle a hole in hard rock when the cap and fuse had failed to detonate the charge?

Answer: Would wait a safe length of time to avoid any delayed explosion due to a slow-burning or damaged fuse, preferably until the next day, and then remove the tamping with a hard wooden stick for loosening and a "spoon" for taking out the dirt. When close to the charge would put in another primed cartridge, retamp, and allow this second detonator to detonate the old charge. Sometimes it will be found necessary to put down a new hole about two feet away from the old hole and load it sufficiently heavy to blow out the burden. A good preventive for such miss fires is to use only electric caps, using two in each hole, one in the bottom and the other in the top, when the charge is heavy. Do not use weak exploders if you want the

best effects from your blasts, nothing weaker than a No. 6 blasting or electric blasting cap is advised, and it is very apparent that the larger sizes will soon be adopted for all general blasting.

Question: How much mud would you use on a mudcap?

Answer: As much as possible, the more the better. Not less than a depth of 6 inches if the best execution is desired.

Question: What is the limit of length for a ditch fired in wet soil with one cap using 60 per cent dynamite?

Answer: I know of no attempt longer than half a mile. This effort was a complete success.

DR. PRATT. Men have been using powder as many farmers use fertilizers; buy it because it is recommended by some one else who had particularly good results, not knowing whether or not it was what they needed. Mr. Squires, of the Dupont Powder Company, is going to take up the different grades, what one is good for.

MR. PEYTON. I have found that our work being contract work did not affect me materially as to the material used. I have been really annoyed, however, that in many instances they have used dynamite when they should have used powder and *vice versa*. The effects of the two materials were very different.

Another waste that comes in: a man doing explosive work, not knowing how much of a charge to make, but wanting to be sure to get enough, will very often put in twice as much as is really needed to accomplish the results he wants. This not only causes a waste of powder, but often damages surrounding property.

The following papers referring to sand and oil surfacing and instructions to patrolmen were distributed to the institute:

Sand and Oil Surface

(Layer Method).

SHAPING SURFACE FOR SAND AND OIL.

SECTION 9. Before the sand and oil is spread, the roadbed shall be shaped to a true surface conforming to the proposed cross section of the highway and rolled by a six-ton roller, unless otherwise ordered by the Engineer.

All depressions occurring must be filled with suitable material and again rolled until the surface is smooth and hard. The cost of shaping and rolling the roadbed shall be included in the price paid for excavation and for furnishing the material used, and shall not be additional thereto.

When, in the opinion of the Engineer, it is necessary to place hardening material on the subgrade of the road, before the sand and oil is laid, the Contractor shall spread clay or other material satisfactory to the Engineer and roll the same in such manner as is satisfactory to the Engineer, and with such weight of roller as he may direct.

SECTION 10. Upon the roadbed prepared as described in Section 9 shall be applied asphaltic oil by the layer method, if so directed by the Engineer, for a width of sixteen (16) feet, by means of a distributor, so arranged as to enable the operator to control the flow and distribute the oil equally and uniformly, leaving no spots or streaks uncovered and to avoid spreading a

surplus of oil at any point, and to completely control the quantity of oil delivered on the road.

The oil shall be spread on the road at a temperature not greater than 250 degrees F., and not less than 180 degrees F., and shall be so heated as to insure its delivery on the road at the required temperature.

There shall be three applications of oil, the quantity for each application to be on the average not less than two-thirds ($\frac{2}{3}$) of a gallon per square yard.

After the first application of oil has been made and as soon thereafter as the Engineer may direct, a layer of sand shall be uniformly spread thereon of sufficient depth to insure a thickness of approximately one (1) inch after rolling.

As soon thereafter as the Engineer may determine, the second and third applications of oil and sand shall be applied in the same manner as in the first application and to the satisfaction of the Engineer.

After three layers of oil and sand have been applied, in the prescribed manner, the road shall be rolled by a roller of such a size and weight as the Engineer may determine.

During the rolling, sand shall be applied to absorb any oil which may flush to the surface, and in such quantities as the Engineer shall direct.

After the rolling has been completed to the satisfaction of the Engineer, a thin layer of sand shall be spread evenly over the entire oiled surface.

All sand shall be clean, sharp and free from loam, clay and adventitious matter of all kinds and shall meet with the approval of the Engineer.

All depressions in any course shall be filled with the same material used in that particular course and shall be rolled until a smooth, true and unyielding surface is obtained.

If at any time before the acceptance of the work any sort of imperfect places or spots shall develop in the surface, the material at all such points shall be removed and replaced with new material and then rolled until thoroughly compacted, and until the joints or edges at which the new work connects with the old become invisible.

All removal and replacement of unsatisfactory material shall be done at the expense of the contractor.

No bituminous work shall be done during rainy weather nor when weather conditions as to temperature or otherwise, are, in the opinion of the Engineer, unfavorable to obtaining satisfactory results.

The Massachusetts Highway Commission will furnish all asphaltic oil necessary in tank cars at the railroad freight station nearest to the site of the work.

The Commission will order the oil when requested so to do by the Contractor.

BITUMINOUS SURFACE.

(Sand and Oil Mixed).

SECTION 10. Upon the roadbed prepared as described in Section 9, the sand and oil surfacing shall be applied as follows:

The sand and oil shall be mixed by hand, or with a mechanical mixer, or by other means furnished by the Contractor, provided the method employed is approved by the Engineer. If the mixing is done by hand, it shall be done on tight platforms, to be furnished by the Contractor, the platforms to be

made of two (2) inch plank, about sixteen (16) feet in length, and in two sections, each about four (4) feet in width.

The Contractor shall furnish and operate at least four (4) mixing platforms and four (4) heating kettles or tanks, and a sufficient number of sand heaters, and if in the opinion of the Engineer the work is not proceeding with sufficient rapidity to insure its completion within the time specified in the contract, the Contractor shall furnish and operate a sufficient number of additional platforms, kettles, and sand heaters to insure the work being so completed within the time specified.

The kettles or tanks for heating the asphaltic oil shall be of a design satisfactory to the Engineer, and of a capacity of not less than sixty (60) gallons each.

The sand shall be dry and so heated that when mixed with the oil a uniform mixture will be secured. Care must be taken not to overheat the sand so as to burn the oil.

The sand and oil shall be mixed in batches of approximately one (1) cubic yard, the sand being spread upon the mixing platforms and the hot oil poured upon it and the whole mass thoroughly turned with shovels, hoes, or rakes, until each particle of sand is completely covered with oil, about sixteen (16) gallons of oil being required for one (1) cubic yard of sand as measured loose in measure box.

The oil when mixed with the sand shall be hot enough to secure a good mixture, and shall be of a temperature between 250 degrees F. and 375 degrees F., depending on nature of oil used.

When the mixing is completed to the satisfaction of the Engineer, it shall not be dumped upon the subgrade, but it shall, without delay, be spread while still warm upon the subgrade from a dumping board, or from a plate of sheet iron satisfactory to the Engineer, to a width of sixteen (16) feet and to a depth of three and one-half ($3\frac{1}{2}$) inches at the center and sides, after rolling with a tandem roller weighing approximately six (6) tons.

After the mixed material is deposited in place and shaped with rakes, etc., it shall before it hardens, be rolled with a horse roller weighing about one ton, then shaped with a road machine or with a suitable scraper and afterwards rolled with a tandem roller to the satisfaction of the Engineer. A hand roller weighing about 200 pounds may be used before rolling with the horse roller, if preferred.

If any depressions appear after scraping and rolling the sand and oil mixture, suitable mixed material satisfactory to the Engineer shall be added. If such depressions are found after the sand and oil has hardened so that the new mixture will not readily bond with the old, the old mixture shall be dug out to a depth satisfactory to the Engineer and the new material added.

Any slight unevenness of the surface shall be remedied by scraping with a road machine or a suitable scraper, and the surface shall then be rolled in a manner to remove all such depressions and leave a smooth and even surface.

After the sand and oil mixture is rolled to a firm surface, free from all irregularities and all surplus loose material, a seal coat of asphaltic oil shall be distributed in two applications at the rate of one-quarter ($\frac{1}{4}$) of a gallon per square yard of road surface for each application. Each application of

oil so applied shall be uniformly covered with a thin layer of sand and rolled to the satisfaction of the Engineer.

The asphaltic oil, when applied to the road surface, shall have a temperature approximately 250 degrees F.

If so ordered by the Engineer, the thickness of the sand and oil mixture shall be increased or diminished at such points as he may direct.

The sand shall be clean, sharp and dry, free from loam, clay and adventitious matter of all kinds. It shall contain no stones larger than one-half ($\frac{1}{2}$) inch in their longest dimensions, or practically any grains or particles which will pass through a screen of fifty (50) meshes to the lineal inch.

The finished surface of the road shall present such crown as shall be directed by the Engineer.

In distributing the oil no overlapping shall be allowed.

The Contractor shall sprinkle the road with water when and as directed by the Engineer.

All depressions in any course shall be filled with the same material used in that particular course and shall be rolled until a smooth, true and unyielding surface is obtained.

If at any time before the acceptance of the work any soft or imperfect places or spots shall develop in the surface, the material at all such points shall be removed and replaced with new material, and then rolled until thoroughly compacted, and until the joints or edges at which the new work connects with the old become invisible.

All removal and replacement of unsatisfactory material shall be done at the expense of the Contractor.

No bituminous work shall be done during rainy weather nor when weather conditions as to temperature or otherwise, are, in the opinion of the Engineer, unfavorable for obtaining satisfactory results.

The Massachusetts Highway Commission will furnish all asphaltic oil necessary for mixing in barrels and for sealing coat in tank cars at the railroad freight station nearest to the site of the work.

The Commission will order the oil when requested so to do by the Contractor.

The Contractor shall be responsible for any and all railroad storage charges and for any loss or damage to material that may accrue after the delivery of the oil at the railroad delivery selected.

The Contractor is to heat the oil in tank cars or otherwise, team the oil to the site of the work, and apply thereon as specified, without compensation additional to the price paid per square yard for bituminous surfacing.

General Instructions to Patrolmen

Inspect your road, its entire section, during a rainy day and locate all pond holes.

Use the road drag immediately after a rain.

Fill all depressions with good material.

On no account use wornout material, sod or sand from ditches.

Remove all glass, tin cans, nails, old iron, etc., from the roadbed.

Renew all defective plank at culverts when necessary.

Should your road surface be very rough, a spike-toothed harrow used while the road is wet will improve an earth, sand-clay, topsoil or gravel surface.

Cut the weeds both sides of the road. Use a mowing machine for this purpose if practical.

Cut all brush at inside of the curves and at railway crossings and culverts.

Remove the ridge between the wheel rut and the gutter by using the one horse cultivator and then use the drag to push the material toward the ditch.

See that all culverts are clear, with outlets and inlets in good order.

Paint all guard rails at culverts and bridges, etc.

Renew all signboards, mileposts, etc., when necessary and give the traveling public all the advice in regard to the routes within your power.

See that all labor and teams in your employ render full and satisfactory service.

Receive all information and criticism from the general public in a courteous manner.

D. H. WINSLOW,

United States Superintendent of Road Construction, Hotel Malbourne, Durham, N. C.

FRIDAY MORNING, FEBRUARY 26.

Relations That Should Exist Between State Highway Commission, County Highway Commission, and Township Highway Commission, and Relations of Highway Engineers to These

ORGANIZATION OF ROAD FORCES.

DR. PRATT.—In discussing this subject I am taking it for granted that that State has a State Highway Commission, and in North Carolina the bill creating a State Highway Commission has passed the House and is now before the Senate, and we do not anticipate any serious trouble or difficulty whatever in having that bill passed by the Senate; we are therefore almost certain of having established by this General Assembly a State Highway Commission. We now have in many counties throughout the State the road work under the county commissioners. In several of the counties, however, there have been created and established what are known as highway or road commissions, and these have been established with a membership varying from three to thirty-six members. Now there is no doubt that when a commission composed of three to five members has full charge of the road work, the efficiency of the road work in that county or township is handicapped. As you increase the number of commissioners the tendency will be to decrease the efficiency of the road work. I would prefer, I think, in almost any county or township that the commission should not consist of over three men, and that such a commission be appointed regardless of politics, the members being appointed because they are men who are interested in the development of their county and are willing to give a certain amount of time to the road work. It is unfortunate if we are not able to have the county as the unit and thus have a board of road commissioners for the county, for when the township is the unit it means usually separate township commissions. Thus in many cases where there are many townships, we have instead of one road commission, anywhere from three to five or ten township road commissions, each separate and distinct. This means that the efficiency of the road work in the county will be decreased. In other words, your county as a county will not have in the end as good a system of roads even with the same

amount of money or as many miles or as economically built roads as it would have obtained if the money was expended with the county as a unit and under a board of road commissioners.

Now there should be a relation—a direct relation—between a state highway commission and a board of county road commissioners. We cannot get the full, close relationship between these commissions until the State is in a position to offer assistance to the county in actual road construction. That is, the State should make appropriations for the actual construction of roads in the counties or give to the county a certain number of State convicts maintained at the expense of the State to be used in road construction work. The proposed State Highway Commission for North Carolina simply contemplates giving to the counties engineering assistance, but only giving it to those counties that make request for it. If, however, we could give the counties actual assistance in construction work, we would then be able to bind the two commissions very close together, because I think when the time does come that we are able to give such assistance in the way of construction work, there will be a clause in the State Highway Commission bill that will make the State Commission responsible for the construction work, for the maintenance of the road after it is built. On the other hand, the county must obligate itself if it receives such assistance to have the road built as determined by the State Highway Commission and maintained as the State Highway Commission directs.

I hope some day we will see in North Carolina the roads of the State divided into three classes:

1. The inter-county or State roads. The State has already authorized the location and construction of the Central Highway across North Carolina, to be known as a State road, the Raleigh-Salisbury Highway, the Wilmington-Charlotte Highway, and the Hickorynut Gap road—all known as State roads—inter-county roads. I hope some day to see North Carolina taking over these State roads so they will be entirely under State supervision, the State paying the whole maintenance cost of same. We are going to have a large fund in the way of the automobile tax, all of which should be used by the State in the maintenance of the public roads.

2. The second class will comprise inter-township or community roads, which should be constructed and maintained by the counties. These roads are important to the county as they connect the various townships with each other and with the county seat, and are the feeders to the State roads.

3. The third class of roads are the township roads, which are of primary importance to the township and of great value in its development and should therefore be built and maintained principally at the expense of the township.

Now, 95 per cent of the traffic of the State and county will pass over the State and county roads. There will probably not be over 5 per cent of the traffic that will go over the township roads, the third class of roads, which are simply community roads often used by only one or two families.

While it may be some time in the future, yet I believe such a system will come to North Carolina as it has come to Massachusetts and other New England states, the Middle West, New Jersey, New York and other states. There is no reason why we should not have such a system here. It is worked out in the other states similar to the way the department of education is worked out here in North Carolina. We have our State system and all the school work is directed under the supervision of the Department of Education, but

we have the county work, the township and city school work—all under the supervision of the central office at Raleigh, the State Board of Education.

At the business meeting last night I made the statement that it seems from the discussions we have had here thus far, we are not paying any particular attention to the road and street work of our cities and incorporated towns, and this is true; but the State Highway Commission when it has reached its fullest development, as I think it will two years from now, will be in a position to give assistance to those who have charge of our street work.

We are unfortunate in North Carolina in permitting towns with a population of a few hundred people to become incorporated towns. As soon as incorporated, it passes out of the jurisdiction of the county commissioners and road commissioners and becomes a corporate body by itself. It then has to raise all its own revenue for street work and for every other development that goes on within its borders unless by some special act of the Legislature the county authorities are authorized to do certain work in that town. Illustrations: Elon College, Gibsonville, Carrboro, etc. The counties of Guilford, Alamance and Orange have not been able to build a county road through those incorporations; consequently, when we have tried to build through highways, those three towns have stated that they did not have money with which to continue roads through their towns. Sometimes it is not practicable to build around the incorporated villages and, as in the above three instances, there are several sections of road one-half to one mile in length that have not been built. I am hoping that in some way or other we will be able through the State Highway Commission and legislation to be able to assist incorporated towns of less than a certain population in building the main highways through such towns. I cannot see any reason why a small collection of people cannot, without incorporating themselves, obtain all the benefits that they expect to gain through an incorporation. In New England, two years ago, I went over hundreds of miles of road in Connecticut, Rhode Island, and Massachusetts. They have little villages, not incorporated, with just the same kind of protection—police duty, lighting apparatus, etc.—as little incorporated towns in North Carolina, and yet they get all the benefits that the county and township get down here through the board of county or road commissioners. And roads there do not stop the minute they reach a little village; they go straight through, whether State, county or township roads.

Now, I want to take up briefly my idea of the relation of the highway commission to the engineer, whether it be a state highway commission or a county highway commission or a township highway commission. I have illustrated on the accompanying chart my idea of the relation that should exist. The highway commission works through the highway engineer. If the best results are to be obtained in the road work in any county or township, the commission must employ a competent road engineer and then give him complete charge of the road work in the county or township. Every other man on the road force is appointed by the engineer, with the approval of the highway commission; and the engineer has the right to discharge any man who does not carry on the work as laid out by him. The method of procedure of the work is not done by the highway commission through rules and regulations to these men, but is done through the road engineer. If the road work is done as outlined above, you can get good results, otherwise you are not apt to, and this is well illustrated in many North Carolina counties where the com-

mission has tried to instruct the engineer how to do his work and have had the authority to go contrary to his directions.

There have been two counties in North Carolina where the superintendent of the convict forces was not subject to the highway engineer, but to the highway commission. In both cases the engineer resigned from the county because the superintendent refused to do the work as outlined by him. The superintendent had his own ideas as to how the road work should be done and insisted on doing it his way. The superintendent of the convict force must be subject to the engineer and not to the commission except through the engineer. In the cases cited the superintendent had been appointed for political reasons, and therefore must not be removed. In a county where the road work is not very large the engineer may be also the chief superintendent of construction. You may combine the two positions in one man, and still the general plan for the organization and the relation of the engineer to the commission does not change. The point I want to emphasize particularly is that the road engineer must be in charge of the work.

Just a word in regard to the purchasing agent. Any supplies that the highway commission expects to purchase must be approved by the road engineer before the contract for such supplies is made. That may seem as though you were conferring upon the engineer extraordinary power, but every single purchase that is made for supplies to be used in road construction has a direct bearing upon the cost per mile of that road. You put your engineer in charge to get the best results, with a certain amount of money, in the way of mileage of roads in your county. If you go ahead and permit the highway commission, without any reference to what is needed, to purchase the road machinery, mules and carts, and other supplies to be used directly in connection with the roads, you may be running your cost account up many thousands of dollars more than it ought to be. Let me illustrate by what happened to a county in Tennessee. Recently I met three men whom I know very well, who represent three of the road-machinery companies of this country. They said they were going down to the county seat of a certain county in Tennessee, where the road commissioners have \$18,000 to spend for road machinery. They do not know what they want, but we are going to tell them, and they will spend that \$18,000 on road machinery,—and they did it. The chances are that \$6,000 would have bought plenty of road machinery for that county. If that had been bought through an engineer, who would probably have been a competent man, he could have cut down their order for machinery and supplies to just what they needed and saved the county many thousands of dollars. Another illustration is in regard to a county in this State. One of our engineers became highway engineer for this county, and one of the conditions he insisted upon before accepting the position was that he must have supervision of the ordering of materials to be used on the road he had charge of. A certain bill of goods was about to be ordered by the commission, when the engineer insisted that, according to his agreement, he must go over it before the contract was let. When he got through revising it and showing them how to order, he had, if I remember correctly, saved from one-half to three-fourths of his yearly salary in that one order. Another illustration: A few days ago a certain county desired to buy a number of mules. They bought them without any reference at all to anybody who was familiar with purchasing mules for road work. It happened, if they had consulted an engineer, from whom they could easily have obtained advice, that they could have bought the same num-

ber of mules and a better quality of mules, at ten dollars per head less. They simply went ahead, placed their order, and bought a much lighter mule at a higher price, when they could have obtained a heavier mule at a lower price. That is why I insist that engineers must have supervision of the purchasing of supplies, and that no supplies shall be purchased by the commission except when the requisition for such supplies is made by the engineer. I want him to also go over the purchase before it is made to see that the estimated cost of those things is within reason. The engineer does know, and in most cases the commission does not, what these things ought to cost and what kind is needed. It applies to road machinery, road surfacing materials, culverts and bridges, and everything that is used in any way in road construction.

There is not a highway commission or board of county commissioners in North Carolina that knows anything about the technical side of the building of bridges, or, as a commission, know after a bridge is constructed whether or not it has been built according to specifications. In a certain county the commissioners in charge of the bridge work had been inserting small advertisements in the local county paper that upon such and such a date bids would be received for the erection of certain bridges. No one interested had seen these advertisements except one particular man within the county, and he had been getting all the bridge work in that county. Two contractors happened, by chance, to see one of these little advertisements; and decided it might be worth while to go down and enter bids, especially if there were two or more small bridges to be built. They investigated and found out what was wanted, and planned to put in bids of \$1,500 to \$1,800 for the bridges. Before entering their bids they heard of and met the contractor who had been getting all the bridge work in that county and knew he had been bidding on that same kind of work and getting the contract at \$3,300. They told him: "We do not want to spoil your plum down here." What was the result. The two agents divided a thousand dollars between themselves and let him have the bid. Now, if that commission had been obliged to submit all bridge work to an engineer that would not have happened. The bridge would have been bought at somewhere near its real value of \$1,500 instead of \$3,300. The time will come when not a single bridge will be built in North Carolina unless its design has been passed upon and its cost estimated by a competent engineer; and the commissioners will not be allowed to let a contract unless the price comes within the estimate of the engineer. This procedure will give the bridge companies a fair and square deal, and as soon as they know and realize this, it will be found that the cost of bridge building in North Carolina will drop very materially. I can give illustration after illustration of the extra cost of bridge work to the counties of North Carolina because this work has been done directly by the commission and the bridge companies and not through the engineer. I suppose I would be safe in saying that six- or eight-tenths of the bridge-letting in North Carolina is done directly by the commissioners upon plans and specifications submitted by the bridge companies themselves, and the commissioners seldom know whether the plans submitted by one company are anything like the plans submitted by another. They know nothing about bridge work, and are not expected to. I have seen specifications given out by commissioners for bridge work which were: we want a bridge so long, so wide, and not to cost over so much money. When the contract was let and the bridge built they were able to tell whether their specifications had been complied with; but whether it was the bridge that

was really needed they did not know. Every bridge should be passed upon by the engineer before the contract is let, and then, before the bridge is paid for, it should be approved by him as to whether or not it has been built according to contract.

In the original Highway Commission Bill was a section that no county in North Carolina should let a contract for a bridge until the plans and specifications for that bridge had been passed upon by one of the engineers of the Highway Commission, and that the bridge should not be paid for by the board until it had been inspected by the engineer and found to come up to specifications. We have several bridges in North Carolina which have supposedly been built according to plans and specifications, were guaranteed by the company and paid for by the county. One of our engineers was working in the county where one of these bridges had been built, and it was necessary for him to take a ten-ton roller across that particular bridge. This bridge had been guaranteed to carry just such a weight, and the county commissioners had paid for it with that understanding. This particular engineer was very sure the bridge would not hold up that weight. He went to the commissioners, and they said it would hold that weight and wrote the company, asking if they would guarantee the bridge to hold that roller, and they said, "No, put in certain girders before you take the roller across." Another case is a bridge in Randolph County. The commissioners accepted and paid for the bridge, and then had to spend \$600 more to bring the bridge up to what was needed and the specifications called for in the contract. The company made that extra \$600. I do not want you to get the idea that I believe all bridge companies are corrupt and are trying to do the counties and commissioners. They are not; some are simply taking advantage of existing conditions, and are perfectly willing to build any bridge that any county will accept as other companies are taking advantage of these conditions to do the counties. Now, if we have the plan of organization outlined above carried out, you will find we will be able to work out a standard design for certain bridges that will get much lower bids from bridge companies.

Some may think that I am advocating too much authority to the engineer in giving him absolute authority over the road work, but I do not think so. He can be removed by the road commission at any time, for cause. Public opinion is being moulded here in North Carolina to the extent that the people are beginning to realize and know that the highway engineer must have charge of the road work if it is to be successfully carried on. With public opinion behind such a policy it will seldom happen that county or township will undertake its roads without putting them under a competent highway engineer.

Public opinion is also going to insist that the State take a hand in this policy and pass laws making it obligatory upon commissioners to employ a competent highway engineer to have charge of all road work built by money raised by sale of bonds. We will find that just as soon as we get such an organization put into practice in this State we can show to the people that such an organization of engineers, superintendents and foremen gives the very best results in road work; that it makes the people's money go much further in road construction; and that they are getting a much better class of road than ever before.

A general bill has been passed by the General Assembly that where State convicts are worked on the public roads, their work must be done under the

supervision of the Highway Division of the Survey. Another bill was also passed that all State convicts, as soon as the prison contracts expire, shall be used on the public roads—given to the counties—and that they cannot work any road in any county that has not been located by a road engineer of the Survey, and the construction work must be done according to the plans and specifications of the engineers of the Survey and under their supervision.

A kick went up at the special session of 1913 in regard to that particular bill. The county said, "No, we want to be able to do as we please when we get the convicts there," but the amendment was voted down, and the work must be done under the supervision of the engineers of the Survey. So, North Carolina has committed herself to ask the General Assembly to adopt that general plan of organization which shows the relation of the engineer to the commission, which applies not only to the State, but to the counties.

DISCUSSION.

MR. FALLIS.—It is not always necessary to have all the various offices in separate men. For instance, the superintendent of roads might be purchasing agent, or one of the assistant engineers might be combined with him, and be made superintendent and purchasing agent, and occasionally the road engineer himself might, in case of small outfits, have control of all that. It depends upon the amount of work to be done in a county, and the size of the outfits to be used, as to how many of these various duties can be performed by one man. The combination of these duties in one man, and all such matters, should go through the road engineer in charge. The combination would, of course, be a matter of economy, and would also often be a matter of increased efficiency; thus one man would have more information at his hand, and thereby the advantage of not having to lose time to get in touch with other men, when so frequently time is of the greatest value. Then there is sometimes quite a little trouble where you have a purchasing agent whose whole duties are not in the road superintendent's office, and whose entire time is not given to the road work, as frequently purchases have to be made when the agent cannot be found.

Many of the details to be worked out should be left to the road engineer to make recommendations to the road commission, and his recommendations should always be followed, because he is the one responsible man, and is more interested in the success of the work in that county than any other one individual connected with the work. Building roads is his life work, by which he makes his living, and he has the same interest in the success of the work that the largest taxpayer or any citizen has in his own personal business, and he should be listened to and his advice followed exclusively so far as the work of organization and road construction is concerned.

Question. Should foremen of convict camps be combined with foremen of construction, as well as have charge of the care and keeping of the convicts?

There are certain combinations that can be made to work, but others that cannot. Guards should not be used in the dual position of guard and foreman of construction work. The man who has charge of the care of the convicts must be under the authority of the road engineer. If the superintendent also holds the position of road engineer, the convict camp must be indirectly under that man. The man who has complete charge of the road work must also have general charge of the convicts. This is because he is the one that is to be held responsible for getting the work out of the convicts, and as the ques-

tion of the discipline and punishment of the convicts must come before the engineer or superintendent, the ultimate authority must be vested in him.

The only way that the foreman of construction has to make the convict work is to report him to the superintendent of the camp. If the superintendent of the camp is not under the authority of the county engineer, he can treat that convict any way he wishes, and nine times out of ten the man or convict that causes trouble does so because he is punished by irresponsible parties. The organization should be such that the convicts on the road are under the county engineer from start to finish. The foremen handling the work directly should not be charged with the duty of caring for or disciplining the convicts.

MR. McALISTER. It is worth while to call attention to the fact that a road engineer who succeeds in delivering the goods is certainly the whole cheese in county work. It has been my limited experience that he has got to use mighty good judgment in delegating authority. Of course, usually the road engineer is really the general superintendent, but the road engineer should have absolute authority to the extent of hiring and discharging men under him. He should use his own discretion as to how much authority to hand down to the superintendent and sub-foreman as to hiring and discharging the men under them. You can get more work if that man knows he is under the "boss" in every way.

The purchasing agent is one of the most important men connected with the economical conduct of construction work. I know one city that bought enough apparatus last year to run any four cities in North Carolina. I will take anybody there and show him. They have spent four times as much as we have in Wilmington, because it was easy-come and easy-go. I think the man in charge of the work should have some say-so in it, because if he does not like that piece of equipment, he can either make it good or bad.

One thing I do not agree with you on, is putting the value of the equipment on the cost of the road. I think that ought to come in on a different head altogether. For this reason, if a county already had equipment it could be used without cost for that particular road.

While the road engineer is the head in regard to the supplies to be used, the road engineer will get the men together and go over with them in regard to the particular kind of machine, etc., they wish to use, etc., so that they can all work in close harmony.

MR. FALLIS. The importance of cost accounting in connection with purchasing agent should always be emphasized. If the cost accounting work is properly carried out, it will be found of great value in guiding the proper and wise purchase of supplies, and it is one, if not the greatest single item to guide the engineer in the economical expenditure of the county's money.

MR. HUGHES. I would like to present a motion that this Institute express by rising vote its appreciation and thanks to Dr. Pratt for making possible such an instructive and valuable Institute as this has been, and also to his associate and the Community Club for their genuine and much-enjoyed hospitality to all those attending the Institute.

Rising vote of appreciation.

Dr. Pratt called attention to Business Session and that three questions are open for general discussion:

How to Improve the Institute.

Correspondence Courses—Are They of Value?

Plan of Coöperation.

It shall be included in the Highway Commission Bill that there shall be held in each county each year a county road institute, under the supervision of one of the engineers of the State Highway Commission, which all county road officials, superintendents, supervisors, foremen, etc., are to attend. It shall be considered part of the official duties of the county road commissioners to attend such institute, and all cost and expenses of their attendance shall be borne by the counties. I believe that by getting together in this way we will get more than at a general institute here.

One thing in regard to improving the institute is this: Would it not be better to have a kind of recess of from fifteen to thirty minutes during the morning sessions of the institute, during which time the men could get together and talk over things?

Question: I want to ask you one thing: Have you an engineer in the State in actual construction work that is systematically going ahead with his work and picking out different materials that are available and sending them up here to you for your opinion?

Answer: No, we are not in a position to do actual testing now. If the Highway Commission Bill goes through, we will be able to get out such reports of road materials in a very reasonable time and not keep them for an indefinite time, as we have done in the past year. The United States Office of Public Roads has done a great deal of that work for us.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*
23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*
24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*
25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D. *In press.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum, Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virginiana Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley, 1915. 8°, . . . pp., 30 pl., 262 figs., 1 map. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

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Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

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Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

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Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

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Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of

Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. Postage 7 cents.

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. Postage 10 cents.

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a letter should accompany sample and stamp should be enclosed for reply.

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JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 44

HIGHWAY WORK IN NORTH CAROLINA

DURING THE CALENDAR YEAR ENDING
DECEMBER 31, 1914

A STATISTICAL REPORT

COMPILED BY

JOSEPH HYDE PRATT, State Geologist

AND

MISS H. M. BERRY, Secretary



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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 1, 1916.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—The North Carolina Geological and Economic Survey, in coöperation with the United States Office of Public Roads, has collected data for the calendar year 1914 in regard to road work in the State, including mileage, finances, administration, maintenance, uses of convict and free labor, etc. The results of these statistics throw considerable light on the road situation in the State, and it is believed that their publication from year to year will help the people of the State to realize, more than anything else, the inefficiency of present methods of road work and administration, and the necessity for the inauguration of more effective and scientific methods. I am, therefore, submitting these statistics in the form of a report, to be published as Economic Paper No. 44 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

HIGHWAY WORK IN NORTH CAROLINA

DURING THE CALENDAR YEAR ENDING DECEMBER 31, 1914

COMPILED BY

JOSEPH HYDE PRATT, STATE GEOLOGIST, AND MISS H. M. BERRY, SECRETARY.

The present report covers an investigation, conducted by the North Carolina Geological and Economic Survey in coöperation with the United States Office of Public Roads, in regard to road mileage, road funds, whether by taxation, bond issue, labor tax, etc.; convict labor on public roads; administrative boards; and systems of maintenance. The statistics given in this report apply to the calendar year ending December 31, 1914, and consist, in the main, of tables, accompanied by a brief explanatory text.

GENERAL STATEMENT REGARDING NORTH CAROLINA AND HER ORGANIZATION AS TO ROAD ADMINISTRATION.

North Carolina has an area of 52,286 square miles, which includes a land area of 48,666 square miles and a water area of 3,620 square miles. Its extreme length from east to west is 503 1-4 miles, and extreme width from north to south is 187 1-2 miles. It is bounded on the north by the State of Virginia, on the east by the Atlantic Ocean, on the south by the States of South Carolina and Georgia, and on the west by the State of Tennessee. It has one hundred counties, varying in size from Robeson, with the largest land area, amounting to 870 square miles, to New Hanover, the smallest, with an area of 162 square miles. Extending from the coast westward to the mountains for a distance of over 500 miles, it includes within its boundaries every variation in topography, from the lowlands of the coastal plain region and the higher region of the piedmont plateau to the steep mountain regions of Western North Carolina. Similar variations are to be found in its climate and geological formations.

All these diverse conditions make the highway problems of the various counties of the State exceedingly complex, and each section has its own problems with regard to location, drainage, surfacing materials, and maintenance. Thus, according to the section of the State in which the county is located, it is found advisable to use macadam, gravel, sand-clay, or topsoil as surfacing materials. Nature

has, however, been very generous in supplying rather abundantly suitable materials for making sand-clay* roads, and because North Carolina is essentially a rural State, containing but few large cities, the sand-clay road for the most part meets traffic conditions over a very wide section. The State is exceedingly well watered, and the problem of culvert and bridge construction and repair is a vital one. All the road work in North Carolina is under the direction of local county or township officials. Up to the last two or three years all assessments were made by county commissioners and the accruing funds spent under their direction. Within the past two or three years, however, especially where bonds have been voted for building public roads, special road commissions have been appointed, either for the entire county (when county bonds have been issued) or for townships or road districts, as the case may be; so that during 1914 the road funds of the State were administered by county commissioners, county road commissioners, township road commissioners or trustees, etc.

The modern movement for better roads in North Carolina may be said to have begun in 1879, when the General Assembly passed what is known as the Mecklenburg Road Law. This was proposed as a general State law, but when passed it applied to only three counties—Mecklenburg, Forsyth, and Stokes. It provided for the working of public roads partly by taxation and partly by the old labor system; but even in this moderate form it was ahead of its time, and in 1881 was repealed. Up to the passage of this law all the road work had been done by the free-labor system, which is still in vogue in a number of counties, in some still being the only system in use, and in others supplemented by a road tax or bond issue. This Mecklenburg law, which was reenacted, can be adopted as the road law of any county by a vote of the county commissioners on petition signed by a number of freeholders in the county.

The General Assembly of 1913 passed a great many acts relating to the issuing of road bonds by counties and townships. There was a great lack of uniformity in these bills and wide variation in the method of issuing the bonds, some being authorized by election on a set date; some by election on petition to county commissioners, others to be issued directly by the county commissioners without vote or petition, and still others to be issued in the discretion of the county commissioners. Some of the acts called for special road or highway commissions to take charge of the road work and others placed the road work under the township commissioners and county commissioners.

There was one law of a general nature passed authorizing any township (except in the counties of Rockingham, Madison, Anson, and

*Sand-clay includes gravel and topsoil.

Robeson) to vote upon bonds, not exceeding \$50,000, upon petition to boards of county commissioners. Elections for these bond issues are to be called by said board upon petition of one-fourth of the qualified voters of any township.

STATE ROAD WORK.

Up to the present time no work has been done directly under the State, except such educational work and engineering assistance as could be rendered by the small appropriation of \$5,000 a year allotted to the highway department of the North Carolina Geological and Economic Survey. Certain special work, however, was allotted to this department by the Legislature of 1913, as the supervision of the construction of the Hickory Nut Gap Road (a link of the Charlotte-Asheville Highway), which is being built by State convicts, and similar supervision of a link of the Central Highway in Madison County. State convicts were also allotted to do this work.

SOURCES OF INFORMATION.

The facts given in this report were obtained from chairmen of boards of county commissioners, chairman of road commissions (both county and township), from registers of deeds, clerks of courts, road engineers, road superintendents, and in some cases from private individuals. The county and road commissions were first written to and given an opportunity to fill out the list of questions. A second request was sent with a personal letter. In many instances third, fourth, and fifth requests were mailed to such parties as it was thought could give reliable answers. In a few cases personal visits were made by engineers of the Geological Survey to road officials and the desired information secured.

In compiling the special-tax figures, access was had to the report of the State Auditor, and we were able to compute the amount of special tax from this, thus checking up these returns. This office keeps in touch with the bond issues which are being voted from time to time by different counties and townships, and thus we were able to check this data with the reports sent in.

As to mileage in the counties, these figures were adjusted with figures which had been received in previous years for total mileage, and the figures for improved mileage were checked by considering average cost per mile with available funds.

While all data given may not be absolutely correct, it is believed that it is as nearly correct as can be had from any available sources

of information. None of the counties or townships in which road work is being done keep accurate cost data, and practically none of the counties have had road maps made of them, so that, while the figures given as to mileage cannot be taken as absolutely correct, yet they are close approximations.

TABLE I

Revenue by Counties and Townships from Direct Taxation (Property and Poll), Special Taxes (Auto Tax, Dog Tax, Central Highway Tax), Labor Tax, and Private Subscription.

It will be noted from this table that in some instances there is a tax levied for the entire county for road improvement, in other instances townships have a special levy for road building, while in still other cases there is a county levy supplemented by additional levies in certain townships.

In column 1 is given the rate for county levies per \$100 worth of property.

In column 2 is given the rate of township levies per \$100 worth of property.

In column 3 is given the rate on polls by counties.

In column 4 is given the rate by townships on the poll.

Column 5 gives the amounts obtained from both property and poll taxes in counties and townships.

Column 6 gives the purposes for which these taxes are levied, as for repair and maintenance of dirt roads; construction of new roads; interest and sinking fund on bond issues; bridges, etc.

Column 7 gives the allotment by counties of the State automobile tax. This tax is supposed to be used for the upkeep of roads, but is sometimes diverted from that purpose.

Column 8 specifies certain other sources of revenue, as private subscriptions; dog taxes; value of labor contributions; tax for Central Highway; Federal funds; excess fees of county officers used for roads; United States Department of Agriculture fund; sale of railroad stock; money borrowed by county commissioners for roads; railroad tax; and chain-gang tax.

Column 9 gives the amounts raised from the sources designated in column 8.

Column 10 gives the total amount for road purposes derived from columns 5, 7 and 9.

Column 11 gives by counties and townships the number of days of free labor required from citizens in rural districts.

Column 12 gives the age limits of citizens who are subject to this labor tax.

Column 13 gives by counties and townships the estimated number of men who are subject to this labor tax.

TABLE I. REVENUE FOR ROAD WORK IN NORTH CAROLINA—BY SPECIAL TAXES.

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Alamance.....		\$0.16 $\frac{2}{3}$	\$	\$	\$	\$ 17,629.98	Const. and repr...
Alexander.....		0		0			Repair.....
Alleghany.....	Ellendale.....		.25		.75	*1,000.00	Repair.....
Anson.....		25-30		75-90c		19,683.00	Constr.....
Ashe.....							Repair.....
Avery.....		.20		0		4,500.00	Repr. dirt roads...
Beaufort.....							Const. and repr...
	Chocowinity.....	.0	.10	2.00		8,256.03	
	Long Acre.....						
	Richland.....						
	Washington.....						
Bertie.....		.20 $\frac{1}{2}$		0		13,724.78	Bridges and repr. dirt roads.....
Bladen.....		.10		.30		6,000.00	Repair.....
Brunswick.....		.25				1,000.00	
	Lockwood's Folly...		.12	.36		4,500.00	Int. and sink. fund
	Northwest.....						
	Shallotte.....						
	Smithfield.....						
	Town Creek.....						
Buncombe.....		.20		0		51,128.76	Const. and repr...
	Black Mountain.....	.20				1,800.00	
Burke.....		.20		0		8,759.44	Const. and repr...
	Morganton.....		.08 $\frac{1}{2}$			2,300.00	Int. and sink. fund
	Silver Creek.....						
Cabarrus.....		.30		0		30,280.00	Const. and repr...
Caldwell.....		0		0			
	Lovelady.....						
Camden.....		0					
Carteret.....		.15		0		5,460.00	Int. and sink. fund const. and repr..
Caswell.....		.10		0		3,000.00	
Catawba.....		.20		0		*12,371.00	Repr. and bridges.
	Hickory.....		.20	0		7,242.65	Int. and sink. fund
	Newton.....		.30			*4,500.00	Int. and sink. fund
Chatham.....		.10		0		6,836.76	Repr. dirt road ...
Cherokee.....		.10		0		*5,000.00	
	Marble Dist.....		.21 $\frac{1}{2}$			*2,000.00	
	Murphy.....		.55			11,000.00	Int. and sink. fund
	Valley Town.....		.35	1.05		6,500.00	
Chowan.....		0					
	First.....		.07 $\frac{1}{2}$		.22 $\frac{1}{2}$	5,300.00	Repair.....
	Second.....		.20		.60		
	Third.....		.20		.60		
	Fourth.....		.20		.60		
Clay.....		.10		0		1,109.00	Repair.....

*Estimated.

GIFTS, LABOR, AND ALL OTHER SOURCES EXCEPT BOND ISSUES DURING 1914.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 1,004.00	Priv. sub.....	\$ 400.00	\$ 19,033.98	3 days or \$1.25	21-45	2,000
131.60	-----	-----	131.60	6	18-45	1,500
-----	-----	-----	1,000.00	-----	-----	-----
1.60	Priv. sub.....	500.00	501.60	6 const., 8 repr.	18-50	700
494.40	{ Priv. sub.....	1,000.00 }	23,677.40	6	18-45	2,000
20.00	{ Labor, etc.....	2,500.00 }	20.00	8	18-45	1,000
8.00	-----	-----	4,508.00	-----	-----	0
903.00	-----	-----	903.00	3	18-45	1,200
-----	-----	-----	8,256.03	-----	-----	-----
856.20	-----	-----	14,580.98	4	18-45	3,000
125.60	Priv. sub.....	500.00	6,625.60	-----	-----	0
100.40	-----	-----	1,100.40	6	18-45	1,000
-----	-----	-----	4,500.00	-----	-----	0
3,495.40	Priv. sub.....	5,000.00	59,624.16	4 days or \$3.00	21-45	2,835
-----	-----	-----	1,800.00	-----	-----	0
316.20	-----	-----	9,075.64	6	18-45	1,200
-----	-----	-----	2,300.00	-----	-----	0
1,100.60	{ Labor.....	200.00 }	32,080.60	0	-----	0
-----	{ Priv. sub.....	500.00 }	-----	-----	-----	-----
439.40	{ Labor.....	400.00 }	2,639.40	6	18-45	3,000
-----	{ Priv. sub.....	1,800.00 }	-----	-----	-----	0
60.00	-----	-----	60.00	6	18-45	1,000
127.60	Labor.....	200.00	5,787.60	6	18-45	800
312.80	{ Dog tax.....	1,800.00 }	5,412.80	4	18-45	1,500
-----	{ Priv. sub.....	300.00 }	-----	-----	-----	0
1,100.40	Priv. sub.....	2,000.00	15,471.40	-----	-----	0
-----	-----	-----	7,242.65	-----	-----	0
-----	-----	-----	*4,500.00	-----	-----	0
284.80	{ Corp. tax.....	1,103.00 }	10,124.56	3	21-45	3,000
-----	{ Dog tax.....	1,100.00 }	-----	-----	-----	-----
-----	{ Priv. sub.....	800.00 }	-----	-----	-----	-----
105.60	Labor.....	500.00	5,605.60	8	21-45	1,400
-----	-----	-----	2,000.00	-----	-----	-----
-----	-----	-----	11,000.00	6	21-45	600
-----	-----	-----	6,500.00	-----	-----	-----
431.80	Priv. sub.....	100.00	531.80	-----	-----	0
-----	-----	-----	5,300.00	-----	-----	0
4.00	-----	-----	1,113.00	4	18-45	300

TABLE I

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Cleveland		\$.25	\$	\$	\$	\$	
	No. 2						
	No. 4						
	No. 6						
	No. 7						
	No. 8						
	No. 9						
Columbus		.10		0		11,266.80	Constr. and repr. and brdg. matr.
Craven	Levied by Township	.20		.60		25,344.40	Const. and repr.
Cumberland		.25		0		26,000.00	Const. and repr. and bridges
Currituck		0		0			
Dare		0		0			
Davidson	Levied by Township	15-20		45-60		21,880.00	Repr. dirt roads
Davie		.20		.60		10,059.33	Int. sinking fund and repair
Duplin		0					Repr. dirt roads
	Calypso						
	Cypress Creek						
	Faison						
	Island Creek		.20			*2,000.00	
	Rose Hill						Int. on bonds
	Wallace						
	Warsaw		.20	.60		*1,500.00	Int. on bonds
Durham		.17		0		47,928.04	Const. and repr. and bridges
Edgecombe		.25					
	Whitakers R. D.		.23			19,082.15	Const. and repr.
	Rocky Mount R. D.		.20	.60		11,119.38	Const. and repr.
Forsyth		.28		0		82,728.64	Const. and repr. and bridges
Franklin		.10				6,482.00	
	Franklinton		.35	1.05		6,800.00	
	Louisburg		.25	.75		4,500.00	
	Youngsville		.30	.90		2,600.00	
Gaston		.25		.75		41,250.00	Const. and repr. bridges
Gates		0		0			Rpr. dirt roads
	Holly Grove		.20	.60		1,318.88	Int. on bonds
Graham		.25½				1,233.00	Repr. dirt roads
	Cheoah		.30	.90		2,700.00	Repr. dirt roads
	Stecoah		.30	.90		1,200.00	Repr. dirt roads
Granville		.30½				28,405.77	Const. and repr.
Greene	By Townships	.59				10,661.26	Int. sinking fund and repairs
Guilford		.23½				70,000.00	All purposes, including bridges
Halifax	By Townships	.25		2.00		32,000.00	Int. sinking fund and repairs

*Estimated.

†For three townships.

‡Sandy Creek Township.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 552.20		\$	\$ 552.20			0
			23,000.00			0
505.60	{ Spec. tax..... Priv. sub..... Wk. civic week ..	{ 603.00 1,200.00 200.00 }	13,775.40	6 days or \$3.00	21-45	4,000
1,135.00	Tax for Cen. Hwy.	3,100.00	29,579.40	0		0
872.00		0	26,872.00	0	0	0
143.60			143.60	3-6	18-45	1,000
61.60		0	61.60	6	18-45	500
1,337.00			23,217.00	†6	18-45	1,000
223.80	Fed. funds.....	12,425.00	22,708.13	0	0	0
304.40			304.40	6	18-45	3,000
	Priv. sub.....	1,800.00	1,800.00			
			2,000.00			
			1,500.00			
1,622.80	Dog tax.....	572.50	50,123.34	0	0	0
1,680.60			20,762.75	0	0	0
			11,119.38			
2,699.80	{ Priv. sub..... Fed. funds.....	{ 1,550.00 1,412.25 }	88,390.69	0	0	0
725.20	Priv. sub.....	350.00	7,257.20	6	21-49	1,000
			6,800.00			
			4,500.00			
			2,600.00			
1,257.00	Priv. sub.....	1,250.00	43,757.00	0	0	0
127.20	Labor given.....	350.00	477.20	0	0	0
			1,318.88			
			1,233.00	4	18-45	700
			2,700.00			
			1,200.00			
854.00	Dog tax.....	984.50	30,244.27	4	21-45	3,000
444.00			11,105.26	6	18-45	2,000
4,708.00	{ Excess fees coun- ty officers..... Priv. sub.....	{ 14,000.00 1,000.00 }	89,708.00	0	0	0
1,424.60	Priv. sub.....	500.00	33,924.60	0	0	0

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Harnett	Hectors Creek	\$	\$	\$	\$	\$	Int. and Const.
	Lillington		.20		.60	5,000.00	
	Upper Little River						
Haywood		.12				6,444.00	Genl. purposes
	Waynesville		.33			7,287.00	
Henderson	By Townships	.20				9,000.00	Int., sink. fund, repairs and brdgs.
Hertford		0					
	Ahoskie		.25		.75	2,636.00	Gen. repr. drt. rds.
	Harrellsville		.25		.75	2,053.00	Gen. repr. drt. rds.
	Maney's Neck		.25		.75	1,821.00	Gen. repr. drt. rds.
	Murfreesboro		.05		.15	378.00	Gen. repr. drt. rds.
	St. Johns		.30		.90	3,117.00	Gen. repr. drt. rds.
	Winton		.25		.75	2,698.00	Gen. repr. drt. rds.
Hoke		.25		.75		7,500.00	Int. and reprs.
Hyde		0					
	Fairfield		.20		.60	696.85	Bridges and repair dirt roads
	Swan Quarter		.20		.60	856.84	
Iredell		.25		.75		36,221.23	Int. sinking fund, reprs. and brgs.
Jackson							
	Cullowhee						
	Dillsboro		10-55		30-1.65	9,118.00	Int. and sinking fund
	Sylva						
Johnston	By Townships	.25				28,874.24	Const. and rpr.
Jones		.20		.60		6,308.79	Repr. dirt roads and grading
Lee		.17		.60		8,655.00	Int. sinking fund, repr. and brdgs.
Lenoir		.18		0		14,287.72	Const., rprs. and bridges
Lincoln		.20		.60		*12,000.00	Int., sinking fund and repairs
Macon		.34				8,150.48	Repr. dirt roads
	Franklin						
McDowell		.10				1,500.00	Repr. dirt roads
	Marion		.30			5,563.39	Int. and skg. fund
	Nebo		.20			*1,200.00	Int. and skg. fund
	Old Fort		.25			3,500.00	Int. and skg. fund
Madison		.30		0		10,916.70	Int. and skg. fund
Martin							
	Robersonville		.16		.50	2,600.00	Int. and skg. fund
	Williamston		.50		1.50	7,019.13	Const. and rpr.
Mecklenburg		.30					
	All Townships		.10			130,720.00	30c const., 10c rpr., const. and rprs.
	Berryhill		.12				
Mitchell		.50		0		11,000.00	Repr. dirt roads and bridges

*Estimated.

†Harp's Road.

‡In three townships.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 698.40	{ Dog tax..... Priv. sub..... Priv. sub.....	{ \$ *200.00 *300.00 ‡3,500.00	{ \$ 1,198.40 8,500.00	6	18-45	1,500
243.20	{ Priv. sub..... Spec. tax.....	{ 400.00 4,000.00	{ 11,037.20 7,287.00	6	18-45	3,000
584.40	Priv. sub.....	1,000.00	10,584.40	5 days or \$2.50	21-45	600
446.00			446.00	6 days or \$3.00	18-45	2,500
			2,636.00			
			2,053.00			
			1,821.00			
			378.00			
			3,117.00			
			2,698.00			
469.20			7,969.20	0	0	0
185.60			185.60	‡6	18-45	500
			696.85			
			856.84			
1,377.40	U. S. Dept. Agri- culture Fund ..	3,802.88	41,401.51	0	0	0
16.00			16.00	4	18-45	2,000
			9,118.00			
1,475.00	Priv. sub.....	1,000.00	36,349.24	6 days in 8 twps.	21-45	1,800
170.00	{ Labor sub..... Labor sub.....	{ 300.00 700.00	7,478.79	2 days or \$1.00	21-45	1,000
296.60			8,951.60	0	0	0
1,044.40	{ Priv. sub..... Sale R. R. stock..	{ 1,500.00 37,500.00	54,332.12	0	0	0
449.20			12,449.20	0	0	0
55.60	{ Priv. sub..... Labor.....	{ 200.00 50.00	8,456.08	4 days or \$2.00	18-45	1,500
105.20			1,605.20	6	18-45	1,000
			5,563.39	4	18-45	600
	Priv. sub.....	62.00	1,262.00	5	21-45	500
			3,500.00	5	21-45	250
6.00	Fed. Fund.....	10,000.00	10,922.70	6 days or \$5.00	18-45	1,500
812.60			812.60	6	21-45	1,700
			2,600.00			
	Spec. tax.....	234.90	7,254.03			
4,699.40			135,419.40	4	21-45	2,000
				2	21-45	
0			11,000.00	4	21-45	1,100

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Montgomery		\$.10	\$.	\$.	\$.	\$ 12,624.73	Const. and rpr....
	Uwharrie		.30			4,303.16	Const. and rpr....
Moore	Bensalem						
	Carthage						
	Deep River						
	Greenwood		.25		.75	*19,000.00	Const. and rpr....
	McNeills						
	Mineral Springs						
	Sand Hills						
Nash	Road Districts						Int. and skg. fund
	Baileys		.30		.90		
	Castalia		.30		0		
	Coopers Creek		.30		0		
	Dry Wells		.30		0		
	Ferrells		.30		.90		
	Griffin		.30		0	*40,000.00	
	Jacksons		.30		0		
	Mannings		.30		.90		
	Red Oaks		.30		0		
	Rocky Mount		.20		.60		
	South Whitakers		.30		0		
New Hanover		0		0		*75,000.00	
Northampton		.20					Const. and rpr....
	Rich Square			1.50		16,308.20	Int. and skg. fund
Onslow		0					Repr. dirt road and bridge
	Jacksonville		.20		.60	3,638.20	
Orange		.35		0		18,780.00	Int. sinking fund and repr.
Pamlico		.20		0		3,579.00	Repr. road and bridges
Pasquotank		.13		0		9,720.27	Rpr. roads and bridges
Pender		0		0			Repr. dirt roads bridges
	Rocky Point		.20		.60	1,200.00	Repr. dirt road
Perquimans		.35		1.05		13,351.41	Repr. dirt road
Person		.25		0		11,613.00	Repr. dirt road
Pitt		.15		.45		15,000.00	Brdgs. and general road work
	Greenville		.30		0	3,500.00	Int. sinking fund and repair
Polk		.52		0		10,010.00	Brdgs. int. sinkg. fund and rpr.
Randolph		.08 $\frac{1}{3}$		0		6,500.00	Bridges, const., repair
Richmond		.33 $\frac{1}{3}$		1.00		29,333.00	Const. and rprs...
Robeson		.21		0		36,521.18	Rpr. dirt roads
Rockingham		.24		0		28,000.00	Const. and rpr.
Rowan		.35		1.05		51,256.00	Const., rpr., and bridges
Rutherford		.15		2.00		16,050.81	Int. sinking fund, const. and rpr.

*Estimated.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 482.00	{ Labor..... Priv. sub.....	{ \$1,000.00 4,200.00 }	\$18,306.73	4 days or \$4.00	18-45	2,000
1,144.20			4,303.16			
			1,144.20	0	0	0
	Priv. sub.....	500.00				
			21,700.00			
	Priv. sub.....	200.00				
	Priv. sub.....	2,000.00				
1,452.60			1,452.60			
			40,000.00			
2,449.60			77,449.60	0	0	0
532.60			532.60	3	21-45	2,700
			16,308.20			
162.00	{ Labor..... Priv. Sub.....	{ 500.00 250.00 }	912.00	4	18-45	1,200
			3,638.20			
441.20	{ Priv. sub..... Dog tax.....	{ 250.00 700.00 }	20,171.20	0	0	0
80.00	{ Labor..... Spec. Tax.....	{ 50.00 175.00 }	3,884.00	4	21-50	1,360
699.80			10,420.07	0	0	0
182.00	Labor.....	6,000.00	6,182.00	8	18-45	1,400
			1,200.00			
238.00			13,589.41	0	0	0
502.40	Labor.....	400.00	12,515.40	0	0	0
2,033.40	Priv. sub.....	500.00	17,533.40	5	18-45	2,000
	Priv. sub.....	3,500.00	7,000.00			
90.00			10,100.00	4	21-45	1,000
749.80	{ Borrowed by Co. Priv. sub.....	{ 26,000.00 30,000.00 }	63,249.80	4	18-45	3,600
1,169.40	{ Labor..... Priv. sub.....	{ 1,000.00 500.00 }	32,002.40	0	0	0
1,437.80			37,958.98	4 days or \$2.00	21-50	7,360
1,053.60			29,053.60	2 days or \$1.00	21-45	2,960
1,986.40	Labor and haul- ing.....	1,500.00	54,742.40	0	0	0
703.20	Priv. sub.....	200.00	16,954.01	0	0	0

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Sampson.....		\$.12	\$	\$ 0	\$	\$ 10,000.00	Int. on bonds and bridges.....
Scotland.....		.20		0		6,993.00	Rpr. dirt road.....
	Laurel Hill.....		.33½		0	*1,500.00	Int. sinking fund and repair.....
	Spring Hill.....		.50½		0	*2,500.00	Int. sinking fund and repair.....
	Stewartsville.....		.30		0	*8,500.00	Int. sinking fund and repair.....
	Williamson.....		.45		0	*4,500.00	Int. sinking fund and repairs.....
Stanly.....		.10		0		5,631.00	Bridges, grading and repair.....
	N. and S. Albemarle.....		.25		.75	7,450.00	Grading and rprs.
Stokes.....							
	Danbury.....		.40		1.20		
	Meadows.....		.30		1.05	*20,000.00	Int. sinking fund and repair.....
	Sauratown.....		.40		1.20		
Surry.....		0					Int. sinking fund.
	Mount Airy.....		.20		.60	6,600.00	Repr. dirt road...
Swain.....		.10		0		2,784.70	Const. and rpr....
Transylvania	By Townships.....	0	15-25c	.45		6,073.40	
Tyrrell.....		0					Repr. dirt road...
	Scuppernon.....		.15			367.00	Constr. and rpr....
Union.....		.25				11,066.00	Constr. and rpr....
	Monroe.....		.14		.75	10,387.55	
Vance.....		.17		.51		16,661.55	Int. sinking fund and repair.....
Wake.....		.25				70,749.41	Repr. and const., gen. road work and bridges.....
	Cary.....						
	Cedar Fork.....						
	Holly Springs.....		†.10			3,812.66	Rpr. and const...
	Middle Creek.....						
	Panther Branch.....						
Warren.....		.25				8,685.00	Repr. and brdgs..
	Warrenton.....		.25		.75	3,750.00	Int. and snk. fund
Washington.....		.20		.60		10,000.00	Constr. and rpr....
Watauga.....		.21½				5,550.30	Constr. and rpr....
Wayne.....	By townships.....		.10		.30	13,757.00	Rpr. dirt roads...
	Goldsboro.....		.20		.60	9,000.00	Constr. and rpr....
Wilkes.....		.10		0		6,292.00	Rpr. dirt roads...
Wilson.....		.25		.75		32,284.00	Repr., constr. and bridges.....
	Toisnot.....		.30		.90	*5,000.00	Rpr., constr. and bridges.....
Yadkin.....				.40		5,135.20	Repair.....
Yancey.....		.15				2,811.00	Repair.....
Totals.....						\$1,782,193.15	

*Estimated.

†Extra.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 493.60	{ Dog tax.....	\$ 2,500.00 }	\$ 14,493.60	6	18-45	3,000
1,100.80	{ Priv. sub.....	1,500.00 }	8,093.80	0	0	0
			*1,500.00			
			*2,500.00			
			*8,500.00			
			*4,500.00			
702.60			6,333.60	4	21-45	1,060
216.80			7,450.00			
			216.80	6	18-45	2,000
			20,200.00			
526.00	R. R. tax.....	200.00	1,126.00	6	18-45	2,000
	Priv. sub.....	600.00	6,600.00			
20.00			2,804.70	4	18-45	1,500
216.60	Chain-gang tax					
128.40	10 cents.....	2,536.70	8,826.70	4 days or \$4.00	18-45	1,500
			128.40	6	21-45	1,500
	Priv. sub.....	17.00	384.00			
612.20	Priv. sub.....	200.00	11,878.20	6	18-45	3,500
			10,387.55			
1,044.00	Priv. sub.....	600.00	18,305.55	0	0	0
3,519.40	Dog tax.....	3,643.00	77,911.81	0	0	0
			3,812.66			
619.60			9,304.60	0	0	0
			3,750.00			
398.40			10,398.40	6 days or \$2.00	21-45	500
5.60			5,601.90	4 N. R., 8 O. R.	18-45	1,500
1,542.00			15,299.00	6	18-45	2,800
	Cent. Hway. tax	500.00	9,500.00			
149.40	{ Labor.....	3,000.00 }	9,641.40	10	18-45	3,000
	{ Priv. sub.....	200.00 }				
1,590.40			33,874.40	0	0	0
			*5,000.00			
107.60			5,242.80	6	18-45	1,500
8.00			2,819.00	6	18-45	3,000
\$76,173.40		\$221,271.73	\$2,105,238.28			121,225

A review of this table shows that seventy-six counties have levied a special tax for road work, the tax being levied for the whole county. The greater proportion of this was spent, in connection with the labor tax, in the repair of the dirt roads of the counties. As a rule, this money is not spent under the direction of a competent road engineer or superintendent, but is apportioned among the townships and used to employ people, unskilled in road building, who live along the road, to work at such times as their crops are not needing them. Thirty-seven counties have from one to twelve townships levying special road tax. There were seventeen counties which had a county road tax, supplemented by special township taxes. Twenty counties had a poll tax for roads and forty-six townships in twenty-eight counties reported a similar tax. Twelve counties reported other special taxes used for road work, such as dog tax, railroad tax, Central Highway tax, chain-gang tax, etc., aggregating \$37,717.70 in 1914; \$76,173.40 from the State automobile tax was reported to have been returned to the counties to be used on the roads. During 1914, \$92,279 were used in forty-eight counties from private subscriptions of money, labor, and teams. One county sold railroad stock to the amount of \$37,500, which was spent on the public roads during 1914, and three counties were aided by the expenditure of Federal funds. This makes a total of \$2,105,238.28 which was reported to have been spent on the public roads during 1914 from taxes of various kinds, private subscriptions, Federal funds, etc. Of this amount, it was reported that \$312,300 was spent for interest and sinking funds on bond issues; and it was estimated that \$674,577.28 was used for maintenance or upkeep of the public roads, \$125,000 for construction and repair of bridges, and \$316,628 for the construction of new roads.

In addition to the above taxes, sixty-seven counties have a labor tax, and these reported during 1914 an aggregate of 121,225 men subject to this tax who worked on an average 5.17 days each during the year, making a total of 676,733 1-4 days of labor put on the roads in these counties during 1914. Valuing this labor tax at \$1 per day, this makes an additional \$676,733.25 spent on the roads during 1914.

TABLE II

County and Township Expenditures for Roads by Bond Issues

This table gives revenue from bond issues. These bonds are issued either as county bonds or township bonds, and frequently county bonds are supplemented by special bond issues in certain of its townships.

Column 1 gives the total amount of bonds by counties and townships issued to January 1, 1913.

Column 2 gives date of sale of these bonds.

Column 3 gives amount of bonds voted during 1913.

Column 4 gives amount of bonds sold during 1913.

Column 5 gives amount of bonds voted during 1914.

Column 6 gives amount of bonds sold during 1914.

Column 7 gives total amount of bonds issued to January 1, 1915.

TABLE II. REVENUE BY BOND ISSUES.

County	Township or District	Bonds Issued to January 1, 1913	Date of Sale	Bonds Voted During 1913	Bonds Sold During 1913	Bonds Voted During 1914	Bonds Sold During 1914	Total Amount of Bonds Issued to January 1, 1915
Alamance		\$ 200,000.00	1908		\$	\$	\$	\$ 200,000.00
Alexander								
Alleghany								
Anson	Township	50,000						50,000
Ashe	Wadesboro	50,000	1912					50,000
Beaufort	Horse Creek			5,800	5,800			5,800
Bertie		20,000	1911	50,000	25,000		25,000	50,000
Bladen	Township	5,000	1907					20,000
								5,000
	Brown Marsh	10,000		10,000	10,000			10,000
	Carver's Creek		1908			5-1-14	10,000	20,000
Brunswick								
	Lockwood's Folly	10,000	1911					10,000
	Northwest		Jan. 1915 contd.			15,000	15,000	15,000
	Shallotte	10,000	1908					10,000
	Smithville			30,000				10,000
	Town Creek	15,000	1911					10,000
		275,000		50,000	50,000		75,000	25,000
Buncombe								400,000
	Black Mountain	20,000	1907					20,000
Burke								
	Morganton			50,000	20,000		15,000	50,000
Cabarrus		105,000		50,000	50,000			*155,000
Caldwell								
Carteret	Lovelady					25,000		25,000
	Morehead			10,000			10,000	10,000
	Newport			3,000	3,000	5,000	5,000	8,000

[illegible]

TABLE II—Continued.

County	Township or District	Bonds Issued to January 1, 1913	Date of Sale	Bonds Voted During 1913	Bonds Sold During 1913	Bonds Voted During 1914	Bonds Sold During 1914	Total Amount of Bonds Issued to January 1, 1915
Graham—	Cheoah.....	\$ 160,000	\$ 1903 and 1909	\$ 15,000	\$ 15,000	\$	\$	\$ 15,000
Granville.....	Bulls Head.....							160,000
Greene—	Hookertown Precinct.....			20,000			20,000	20,000
	Suggs Township.....			10,000			10,000	10,000
	Jason.....			10,000			10,000	10,000
	Olds.....			20,000			20,000	20,000
	Ormonds.....			20,000			20,000	20,000
	Shine.....			10,000			10,000	10,000
	Snow Hill.....			20,000			20,000	20,000
Guilford.....		300,000	1905 and 1909					300,000
Halifax—	Enfield.....			40,000		60,000	40,000	100,000
	Halifax.....			60,000			60,000	60,000
Harnett—	Barbecue.....						10,000	10,000
	Black River.....						2,500	2,500
	Hector's Creek.....							15,000
	Lillington.....						20,400	20,000
	Upper Little River.....						20,000	20,000
Haywood—	East Fork.....							10,000
	Waynesville.....	50,000						50,000
Henderson.....	Edneyville.....					25,000	25,000	25,000
	Hendersonville.....					12,000	12,000	12,000
	Hooper's Creek.....					50,000	50,000	50,000
Hoke.....		50,000	1911					50,000
Iredell.....				400,000	400,000			400,000

Jackson—	Cullowhee.....			30,000		15,000	30,000
	Dillsboro.....			15,000		15,000	15,000
	Sylva.....			30,000		30,000	30,000
Johnston—	Bulah.....					40,000	40,000
	Ingram.....					40,000	40,000
	Meadows.....					50,000	50,000
Lee.....	Sanford.....	100,000	1912				100,000
		15,000		200,000			15,000
Lincoln.....							200,000
McDowell—	Marion.....			50,000			50,000
	Nebo.....			10,000			10,000
	Old Fort.....			20,000			20,000
Macon—	Franklinton.....			90,000		90,000	90,000
				300,000		150,000	300,000
Madison.....	Mars Hill.....	20,000					20,000
Martin—	Robersonville.....					15,000	15,000
	Williamston.....	20,000		10,000		10,000	40,000
		300,000					300,000
Mecklenburg.....	Grassy Creek.....					30,000	30,000
Mitchell—	Carthage.....						32,000
	Deep River.....	12,000		20,000		20,000	50,000
	Greenwood.....			12,500			12,500
	McNeill.....	10,000					10,000
	Mineral Spring.....			7,000			7,000
	Sand Hill.....	10,000		10,000			20,000
Nash—	Rocky Mount, R. D.....	70,000	1907 and 1912				70,000
	N. Whitakers Twp.....	50,000					50,000
	Cooper's Creek, R. D.....			10,000		10,000	10,000
	Dry Wells, R. D.....	20,000					20,000
	Griffin, R. D.....	10,000					10,000
	Mannings, R. D.....			50,000		50,000	50,000
	S. Whitakers, R. D.....	10,000					10,000

A review of this table shows that up to January 1, 1915, 24 counties and 120 townships had issued or voted bonds amounting to \$8,961,800; that of these, 3 counties and 36 townships voted bonds during 1914, amounting to \$1,065,500. In 1913 there were \$2,338,800 in bonds sold, and during 1914 \$2,345,000 worth of bonds were sold by 7 counties and 55 townships.

TABLE III

Classified Road Mileage.

This table gives road mileage by counties.

Column 1 gives, by counties, the total number of miles of public roads in the State. These figures are only approximately correct.

Column 2 gives by counties the total number of miles of macadam roads in the State.

Column 3 gives the number of miles of macadam roads constructed in the various counties during 1914.

Column 4 gives, by counties, the total number of miles of sand-clay or topsoil roads in the State.

Column 5 gives, by counties, the number of miles of sand-clay or topsoil roads built during 1914.

Column 6 gives, by counties, the total number of miles of gravel roads in the State.

Column 7 gives, by counties, the number of miles of gravel road built during 1914.

Column 8 gives, by counties, the total number of miles of specially surfaced road (including bituminous macadam, asphalt macadam, Tarvia, and concrete roads) in the State.

Column 9 gives the number of miles of specially surfaced road built during 1914.

Column 10 gives the kinds of surfacing material used in columns 8 and 9.

Column 11 gives, by counties, the total number of miles of road graded and shaped but not surfaced.

Column 12 gives the number of miles of road graded but not surfaced during 1914.

Column 13 gives, by counties, the number of miles of unimproved dirt road.

TABLE III. CLASSIFIED ROAD MILEAGE IN NORTH CAROLINA DURING 1914.

County	Number Miles Public Road	Total Number Miles Macadam	Number Miles Macadam Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Total Number Miles of Spe- cially Surfaced Roads	Number of Spe- cially Surfaced Miles of Spe- cially Built 1914	Kind of Specially Surfaced Road	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Alamance	600	50		8							8	5	734
Alexander	200												200
Alleghany*	300										20		280
Anson*	*500	15		32	19	36	15				13	13	404
Ashe	500												500
Avery	300												300
Beaufort	400			4	2	1							395
Bertie	800			20	5						200		580
Bladen	200			6	3						20	20	174
Brunswick*	*400			*48	*20						20	20	332
Buncombe	700	75		48	4						378	27.5	199
Burke	300			10	6			6		Asphalt Mac- adam			259
Cabarrus*	600	16		45	20						25		489
Caldwell	500	3		6	5						50	5	456
Camden	200										35	10	200
Carteret	200			20	10								170
Caswell	400	1.5									10	7	398.5
Catawba	450			100	25						20	10	330
Chatham	600										4	4	596
Cherokee	400	13	5	32	5	2	2				35		318
Chowan	185												185
Clay	135												135
Cleveland	800			80	30	25					15		680
Columbus	1,150			35	25	2					250	125	863
Craven	930			4							35	15	891
Cumberland	600			105	35						175		320
Currituck	100			3									97
Dare	70												70

*Estimated

TABLE III—Continued.

County	Number Miles Public Road	Total Number Miles Macadam Road	Number Miles Macadam Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Number of Miles of Spe- cially Surfaced Road	Kind of Specialty Surfaced Road	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Davidson.....	800	3		10	3					10	10	777
Davie.....	263			57	57					10	10	196
Duplin.....	800			66	10					10	10	724
Durham.....	450	97	1			16	7	5		15	7	317
Edgecombe.....	750			20	5					10	10	720
Forsyth.....	750	70		50	20	5		4	Tarvia	10	10	611
Franklin.....	*500			205	50			5	Bituminous Macadam	5	5	285
Gaston.....	*500	*110	8	*40	*14					*5		345
Gates.....	300									20	20	280
Graham.....	*250			*3						2	2	245
Granville.....	700			135	10							565
Greene.....	300			40	40							260
Guilford.....	1,000	110		100	40	10						780
Halifax.....	600			80	55	20	6			10	10	490
Harnett.....	500			40	10					25	5	435
Haywood.....	300	20	4			2	2			150		128
Henderson.....	500			60	60							340
Hertford.....	*600									100	35	*600
Hoke.....	200			75	25					25	25	100
Hyde.....	300									100		200
Iredell.....	700	25		240	40					20		415
Jackson.....	400									20	20	380
Johnston.....	900			200	50					20	10	680
Jones.....	225			4	4					15		206
Lee.....	250			32	20	36	15					82
Lenoir.....	500			65	30							435
Lincoln.....	400			*100	*50					*20	*20	280
McDowell.....	350	8		36	36					40	3	266

[illegible]

TABLE III—Continued.

County	Number Miles Public Road	Total Number Miles Macadam Road	Number Miles Macadam Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Total Number Miles of Special- ly Surfaced Road	Number of Miles of Spe- cially Surfaced Road Built 1914	Kind of Specially Surfaced Road	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Wayne	*1,000			*200	*50	*10	*5				*300	*20	*490
Wilkes	1,000	1									150	50	849
Wilson	800	24		35	9	1					40		700
Yadkin	300												300
Yancey	80			3	3						17	17	60
Totals	50,758	1,105	48 $\frac{1}{2}$	4,363.5	1,019.5	502	211	56.25	15.25		4,181.5	1,290.5	40,549.75

A review of this table shows that the total mileage of public roads reported for 1914 was 50,758 miles, of which there were 1,105 miles of macadam, 4,363 $\frac{1}{2}$ miles of sand-clay or topsoil; 502 miles of gravel; 56 $\frac{1}{4}$ miles of specially surfaced (concrete bituminous macadam, asphalt macadam, etc.); and 4,181 $\frac{1}{2}$ miles of road graded but not surfaced. This makes a total of 10,208 $\frac{1}{4}$ miles of surfaced and improved road in the State, as reported for 1914. Of this mileage of improved road, the following were constructed during 1914:

48 1-6 miles macadam,
1,619 1-2 miles sand-clay or topsoil,
211 miles of gravel,
15 1-4 miles of specially surfaced,
1,290 1-2 miles of graded but not surfaced.

This leaves 40,549 $\frac{1}{4}$ miles of unimproved dirt roads in the State.

TABLE IV

Use of Convict Labor in Road Construction During 1914

This table gives the counties which use short-term prisoners on their own public roads and the counties which lease their convicts for road work to other counties. In a few instances the State, through special enactment, has undertaken to build certain roads with convict labor.

Column 1 gives the average number of convicts, by counties, used on the public roads during 1914.

Column 2 gives the names of counties to whom other counties leased their convicts during 1914.

Column 3 gives the average cost per day of guarding, feeding, and general care of convicts.

Column 4 gives the number of State convicts used in road work, by counties. The General Assembly of 1913 passed an act by which any county or township or good roads district may obtain State convicts by making application for them and by having their plans furnished or approved by the State Geological and Economic Survey. Roads built by such labor must be under the direction of the State Geological and Economic Survey.

Column 5 gives the opinions of those making the reports in regard to the effect of such work upon the convict and its value to the counties or the State.

Column 6 gives the estimated value in money of the convict labor used on the roads, estimating the number of days worked at 200 and the value per day per convict at \$1.25.

TABLE IV. USE OF CONVICT LABOR IN ROAD CONSTRUCTION IN NORTH CAROLINA DURING 1914.

County	Township	Average Age No. of Con- victs Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding, Feeding, Etc.	State Con- victs, Number	Value of Such Work to Convict and to County	Esti- mated Value of Con- vict Labor at \$1.25 Per Day
Alamance				\$			\$
Alexander							
Alleghany							
Anson		30		.75		Good results	7,500
Ashe			Rockingham				
Avery							
Beaufort		30					7,500
Bertie		5		\$12 per mo.		This is what they should do	1,250
Bladen							
Brunswick			Columbus			Best use to be made of them	37,500
Buncombe		150		.75		Expensive without a large force.	7,500
Burke				.65			
Cabarrus		30	Catawba				
Caldwell			Pasquotank				
Canden			Craven and Edgecombe				
Carteret							
Caswell							
Catawba			Leased				
Chatham							
Cherokee			Pasquotank				
Chowan			Haywood				
Clay							
Cleveland							
Columbus		35		.75		Good results under proper government.	8,750
Craven		25		.57½		The ideal work for them. Everything in favor of it.	6,250
Cumberland		28		.50			
Currituck			Pasquotank				

TABLE IV—Continued.

County	Township	Average No. of Convicts Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding, Feeding, Etc.	State Convicts, Number	Value of Such Work to Convict and to County	Estimated Value of Convict Labor at \$1.25 Per Day
Dare.....				\$			\$
Davidson.....	Lexington.....	20					5,000
Davie.....			Guilford			The very best place for them.	
Duplin.....		68		.60		Have all we can work of our own.	17,000
Durham.....		40				Healthful and beneficial to general condition if properly cared for.	10,000
Edgecombe.....						Convicts should be used on highways.	32,500
Forsyth.....		130		.71			
Franklin.....	Louisburg.....	25				Worked well in Louisburg Township.	6,250
Gaston.....		50				The only practical way of handling evil doers.	12,500
Gates.....			Pasquotank				
Graham.....			Person			Approve of it.	
Granville.....		9				Entirely satisfactory where properly handled.	2,250
Greene.....		76		.50		The best way to handle them is on public roads.	19,000
Guilford.....		30		1.00		It is specially good in that he is fitted to do valuable work while in service.	7,500
Halifax.....							2,500
Harnett.....	(One township).....	10		.60		Should be worked on county highways.	5,500
Haywood.....		20-24		.80-.90	40	Where they all should be worked.	14,500
Henderson.....		18	Halifax and Warren, Rich Square Twp., Northmp.			Proper thing	
Hertford.....							
Hoke.....							
Hyde.....							
Iredell.....		25		1.25		Do not approve of it.	7,250
Jackson.....			Haywood				

TABLE IV—Continued.

County	Township	Average No. of Convicts Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding Feeding, Etc.	State Convicts, Number	Value of Such Work to Convict and to County	Estimated Value of Convict Labor at \$1.25 Per Day
Perquimans			Edgecombe	\$		Think the convict poor labor for the road.	\$
Person		38		.50		They should be used on public roads	2,000
Pitt		40-45		.55			11,250
	Greenville	30		.50			
Polk			Henderson, Rutherford, McDowell, Gaston			Camps using them build good roads; in favor of it	
Randolph		10		1.00	50	Expensive but sometimes other labor not available	
Richmond		40		.60			2,500
Robeson		60		.64			10,000
Rockingham		60		1.00			15,000
Rowan		90				Very little cheaper than contracting roads	15,000
Rutherford			Henderson				22,500
Sampson		20		.50		Best place to work them	5,000
Scotland			Richmond			In favor of it	
Stanly		25		.85			6,250
Stokes			Rockingham			The place for them	
Surry						O. K.	
Swain				.75			2,500
Transylvania		10				In favor of it	
Tyrrell				.54			7,500
Union		30	Franklin and Warren				
Vance				1.00		Thoroughly pleased with results here	19,750
Wake		79				Do not think much of it	3,500
Warren		14				Good	1,750
Washington							
Watauga		7					

Wayne.....	35		.65	Better than hired labor.....	8,750
Wilkes.....		Catawba.....		Would be good plan.....	
Wilson.....	55		.50	Think they should be so employed.....	13,750
Yadkin.....					
Yancey.....					
Totals.....	1,888				\$ 460,250

Table IV gives data in regard to the use of convict labor on the public roads in 1914. This shows that there were 1,888 short-term convicts used by the counties during 1914 and 155 State convicts. Thirty-one counties leased their convicts to other counties for use on public roads. The average cost for guarding, feeding, and general care of a convict ranges from 45 cents to \$1 per day. Estimating the value of the convict labor at \$1.25 per day per man and the number of days worked during the year at 200, gives the total value of convict labor for 1914 of \$460,250.

TABLE V

What Was Spent on Roads in 1914 and How It Was Spent

In this table is brought together the revenue from all sources (including taxes, subscriptions, bond issues, labor tax, convict labor, etc.) used on the public roads during 1914. None of the counties have kept exact figures in all cases as to the proportion of bond issues spent during this year, but it is believed that the figures given are fairly accurate. In this table is also given the number of miles of road surfaced and graded, together with estimated cost per mile of such improvements. Along with this statement is worked out the total amount spent in road construction during 1914 and an estimated statement as to the amount spent in the maintenance or upkeep of all the public roads during 1914.

Column 1 gives the funds from all sources except bond issues. This is given entirely by counties, but in many instances the sums given represent money raised by special taxes in certain townships. This, however, is given in detail in Table I.

Column 2 gives the estimated proportion of funds raised from bond issues spent during 1914. This is given by counties and townships.

Column 3 gives the estimated value of the free-labor tax, valuing it at \$1 per day per man.

Column 4 gives the estimated value of convict labor as worked out in Table IV.

Column 5 gives the total amounts from all sources spent on road work in 1914.

Column 6 gives the number of miles of macadam road built in 1914, and column 7 gives the cost per mile of this type of road.

Column 8 gives the number of miles of sand-clay or topsoil road built in 1914, and column 9 the cost of this type of road per mile.

Column 10 gives the number of miles of gravel road built in 1914 and column 11 the cost per mile.

Column 12 gives the number of miles of specially surfaced road (including asphalt, macadam, bituminous macadam, concrete, etc.) built in 1914, and column 13 gives the cost per mile of these types of road.

Column 14 gives the number of miles of road graded but not surfaced during 1914, and column 15 gives the cost per mile for grading.

Column 16 gives the estimated total cost of roads graded and surfaced during 1914.

Column 17 gives the estimated amount spent on maintenance and repair during 1914.

Columns 16 and 17 do not represent all the money given in column 5, as in many instances a certain amount of the road tax is used for interest and sinking fund on bond issues and in some instances for bridge building or bridge maintenance.

TABLE V. WHAT WAS SPENT ON ROADS

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- tract Labor at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Alamance		\$ 19,033.98	\$	\$ 6,000	\$	\$ 25,033.98	
Alexander		131.60		9,000		9,131.60	
	Ellendale	1,000.00				1,000.00	
Alleghany		501.60		9,800		10,301.60	
Ans n		23,677.40		12,000	7,500	43,177.40	
Ashe		20.00		8,000		8,020.00	
Avery		4,508.00				4,508.00	
Beaufort		9,159.03	25,000	3,600	7,500	25,259.03	
Bertie		14,580.98		12,000	1,250	27,830.98	
Bladen		6,625.60				6,625.60	
	Brown Marsh		5,000			5,000.00	
	Carver's Creek		5,000			5,000.00	
Brunswick		5,600.40				5,600.40	
	Northwest		10,000			10,000.00	
	Shallotte		5,000			5,000.00	
	Town Creek		5,000			5,000.00	
Buncombe		61,424.16	50,000	11,340	37,500	92,764.16	
Burke		11,375.64				11,375.64	
	Morganton		10,000			10,000.00	
Cabarrus		32,080.60	25,000		7,500	64,580.60	
Caldwell		2,639.40		18,000		20,639.40	
Camden		60.00		6,000		6,060.00	
Carteret		5,787.60				5,787.60	
	Morehead		5,000	4,800		9,800.00	
	Newport		5,000			5,000.00	
Caswell		5,412.80		6,000		11,412.80	
Catawba		27,214.05				27,214.05	
	Hickory		10,000			10,000.00	
	Newton		10,000			10,000.00	
Chatham		10,124.56		9,000		19,124.56	
Cherokee		25,105.60		3,600		28,705.60	
	Murphy		40,000			40,000.00	5
Chowan		5,831.80				5,831.80	
Clay		1,118.00		1,200		2,313.00	
Cleveland		23,852.20				23,852.20	
	No. 4		10,000			10,000.00	
	No. 6		15,000			15,000.00	
	No. 7		5,000			5,000.00	
	No. 8		5,000			5,000.00	
Columbus		13,775.40		24,000	8,750	46,525.40	
Craven		29,579.40			6,250	35,829.40	
Cumberland		26,872.00				26,872.00	
Currituck		143.60		5,000		5,143.60	
Dare		61.60		3,000		3,061.60	
Davidson		23,217.00		6,000	5,000	34,217.00	
Davie		22,708.13	120,000*			142,708.13	
Duplin		5,604.40		18,000		23,604.40	
	Island Creek		7,500*			7,500.00	
Durham		50,123.34			17,000	67,123.34	1
Edgecombe		31,882.13			10,000	41,882.13	
Forsyth		88,390.69	25,000		32,500	145,890.69	
Franklin		21,157.20			6,250	27,407.20	
	Franklinton		20,000			20,000.00	
	Louisburg		40,000			40,000.00	

*Estimated.

DURING 1914, AND HOW IT WAS SPENT.

Cost Per Mile	Number Miles Sand-Clay and Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Surfaced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in 1914	Estimated Amount Spent in Maintenance and Repair During 1914
\$		\$		\$		\$	5	\$ 500	\$ 2,500	\$ 11,533.98
	19	200-350	15	600			13	600	22,015	10,131.60
	2	800*							1,600	9,901.60
	5	300*							1,500	20,562.40
	3	500*					20*	500*	11,500	8,020.00
							10*	500*		4,508.00
							10*	500*		23,659.03
	20	900								25,330.98
										3,125.60
	4	1,000					27.5	2,000	59,000	33,764.16
	6	1,000*							10,000	9,075.64
	6	1,000*								
	20	1,500					5	1,000	35,000	29,580.60
	5	1,200*					10	800	14,000	6,639.40
										6,060.00
	10	500					7	200	6,400	12,587.60
	25	1,050					10	800	34,250	11,412.80
										1,222.05
	5	1,850	2	3,080			4	800	3,200	15,924.56
4,600	5	1,850	2	3,080					38,410	10,795.60
										5,831.80
	30	1,000								2,313.00
									30,000	2,852.20
	25	350					125	200	33,750	8,775.40
							15	750	11,250	24,577.40
	35	600							21,000	5,872.00
										5,143.60
										3,061.60
	3	1,000*					10	750	10,500	23,717.00
	57	2,000					10	800	122,000	10,708.13
	10	400-1,000					10	50	7,500	21,604.40
5,000			7	2,250	5	2,800*	7	1,500-2,000	47,000	18,123.34
	5	1,000*					10	500	10,000	31,882.13
	20	1,800			4	8,000*	10	1,000	78,000	28,890.69
	50	500		1,000	5	2,000*	5	500	62,500	11,007.20

TABLE V—

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- tract Labor at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Gaston		\$ 43,757.00	\$	\$	\$ 12,500	\$ 56,257.00	8
Gates		1,796.08				1,796.08	
	Holly Grove		6,500			6,500.00	
Graham		5,133.00				5,133.00	
	Cheoah		3,000			3,000.00	
Granville		30,244.27		12,000		42,244.27	
Greene		11,105.26		12,000	2,250	25,355.26	
	Bulls Head		6,000			6,000.00	
	Hookertown						
	Precinct of Sugg Township		3,000			3,000.00	
	Jason		3,000			3,000.00	
	Olds		6,000			6,000.00	
	Ormondsville		6,000			6,000.00	
	Shine		3,000			3,000.00	
	Snow Hill		6,000			6,000.00	
Guilford		89,708.00			19,000	108,708.00	
Halifax		33,924.60			7,500	41,424.60	
	Enfield		40,000			40,000.00	
	Halifax		60,000			60,000.00	
Harnett		9,698.40		9,000	2,500	21,198.40	
	Black River		2,500			2,500.00	
Haywood		18,374.20		18,000	5,500	41,874.20	4
	Beaverdam		10,000			10,000.00	
Henderson		10,584.40		25,000	3,000	53,084.40	
	Edneyville		12,000			12,000.00	
	Hendersonville		50,000			50,000.00	
Hertford		13,149.00		15,000		28,149.00	
Hoke		7,969.20		10,000		17,969.20	
Hyde		1,739.29				1,739.29	
Iredell		41,401.51		50,000	7,250	98,651.51	
Jackson		9,134.00		8,000		17,134.00	
	Cullowhee		15,000			15,000.00	
	Dillsboro		15,000			15,000.00	
	Sylva		30,000			30,000.00	
Johnston		36,349.24		10,800	5,000	52,149.24	
	Meadows		25,000			25,000.00	
Jones		7,478.79		2,000		9,478.79	
Lee		8,951.60		40,000		48,951.60	
Lenoir		54,332.12			12,500	66,822.12	
Lincoln		12,449.20		90,000*		102,449.20	
Macon		8,456.08		6,000		14,456.08	4
	Franklin		40,000*			40,000.00	
McDowell		21,930.59		12,000		33,930.59	
	Marion		25,000			25,000.00	
	Nebo		5,000			5,000.00	
	Old Fort		20,000			20,000.00	
Madison		10,922.70		130,000	9,000	149,922.70	
Martin		10,666.63			10,200	20,866.63	
	Robersonville		9,000			9,000.00	
	Williamston		5,000			5,000.00	
Mecklenburg		135,419.40		8,000	25,000	163,419.40	20
Mitchell		11,000.00		4,400		15,400.00	
	Grassy Creek		9,000			9,000.00	
Montgomery		22,609.89		8,000		30,609.89	

Continued.

Cost Per Mile	Number Miles Sand-Clay and Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Surfaced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in, 1914	Estimated Amount Spent in Maintenance and Repair During 1914
\$3,000-4,000	14	700-1,250		\$		\$	20	325	\$ 41,650 6,500	\$ 14,607.00 1,796.08
							2	1,500	3,000	5,133.00
	10	250-1,500							8,750	15,894.27
	40	800							32,000	15,155.26
	40	1,000*							40,000	36,168.00
	55	1,300	6	2,100			10	600-700	90,600	40,824.60
	10	1,000*					5	600*	13,000	10,698.40
4,000*			2	2,000*					20,000	31,874.20
	60	800-1,000					35	500	71,500	27,584.40
										28,149.00
	25	500					25	100	15,000	2,969.20
										1,739.29
	40	1,650							66,000	14,651.51
							20	3,000*	60,000	17,134.00
	50	500					10*	200*	27,000	42,149.24
	4	500							2,000	5,478.79
	20	1,000	15	1,500					42,500	451.60
	30	1,000							30,000	36,822.12
	50*	1,500*					20*	1,000*	95,000	1,449.20
4,000*	5	1,800*					11	1,500*	41,500	7,956.08
							6			
	36	2,000					3	600-5,500	81,150	12,000.00
	20	2,000								
	6	2,000*								
	10	2,000*								
	4	3,000*					60	2,000*	132,000	9,000.00
	55	250*					5	50*	14,000	16,866.63
	15									
	40									
4,000	30	1,500							125,000	43,419.40
							3	3,000	9,000	15,400.00
	15	150	20	200			25	50	7,500	21,609.89

TABLE V—

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- vict Labor at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Moore		\$ 22,844.20	\$	\$	\$	\$ 22,844.20	
	Carthage		3,900			3,900.00	
	Mineral Springs		7,000			7,000.00	
Nash	(Road Districts)	41,452.60			15,250	56,702.60	
	Coopers Creek		10,000			10,000.00	
	Rocky Mount		25,000			25,000.00	
	Mannings		30,000			30,000.00	
New Hanover		17,449.60	40,000*		25,000	57,449.60	1 ¹ / ₆
Northampton		16,840.80		8,100	5,000	29,940.80	
	Jackson		8,000			8,000.00	
	Rich Square		4,000			4,000.00	
Onslow		4,550.20		4,800		9,350.20	
	Jacksonville		2,000			2,000.00	
Orange		20,171.20	215,000			235,171.20	
Pamlico		3,884.00		5,440		9,324.00	
Pasquotank		10,420.07	5,000		7,500	22,920.07	
Pender		7,382.00		11,200		18,582.00	
Perquimans		13,589.41				13,589.41	
Person		12,515.40			2,000	14,515.40	
Pitt		24,533.40		10,000	11,250	46,783.40	
	Greenville		40,000			40,000.00	
Polk		10,100.00	96,000	4,000		110,100.00	
Randolph		63,249.80		14,400	2,500	80,149.80	
Richmond		32,002.40	6,000		10,000	48,002.40	
Robeson		37,958.98		29,440	15,000	82,398.98	
Rockingham		29,053.60	30,000	5,920	15,000	79,973.60	
Rowan		54,742.40			22,500	77,242.40	3
Rutherford		16,954.01	260,000			276,954.01	
Sampson		14,493.60	25,000	18,000	5,000	62,493.60	
Scotland		25,093.80	10,000			35,093.80	
Stanly		13,783.60		4,240	6,250	24,273.60	
Stokes		20,416.80		12,000		32,416.80	
	Danbury		15,000			15,000.00	
	Meadows		40,000			40,000.00	
	Sauratown		50,000			50,000.00	
Surry		7,726.00		12,000		19,726.00	
	Mount Airy		58,000			58,000.00	
Swain		2,804.70		6,000		8,804.70	
Transylvania		8,826.70		6,000	2,500	17,326.70	
Tyrrell		512.40		9,000		9,512.40	
Union		22,265.75		21,000	7,500	50,765.75	2
Vance		18,305.55	100,000			118,305.55	
Wake		81,724.47			19,750	101,474.47	
Warren		13,054.60			3,500	16,554.60	
	Warrenton		17,000			17,000.00	
Washington		10,398.40		3,000	1,750	15,148.40	
Watauga		5,601.90		9,000		14,601.90	
Wayne		24,799.00		16,800	8,750	50,349.00	
	Goldsboro		54,000			54,000.00	
Wilkes		9,641.40		30,000		39,641.40	
Wilson		38,874.40			13,750	52,624.40	
Yadkin		5,242.80		9,000		14,242.80	
Yancey		2,819.00	54,000	18,000		74,819.00	
Totals		2,044,738.28	2,422,400	591,080	460,250	5,406,945.18	48 ¹ / ₆

Continued.

Cost Per Mile	Number Miles Sand-Clay or Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Sur- faced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in 1914	Estimated Amount Spent in Mainte- nance and Repair During 1914
\$-----	20	\$ 300*	-----	\$-----	-----	\$-----	5	\$ 200*	\$ 10,900	\$ 15,344.20
-----	13	300	-----	-----	-----	-----	-----	-----	-----	-----
-----	29	800-1,000*	10	1,800*	-----	-----	125	400-500*	100,350	21,352.60
-----	25	-----	-----	-----	-----	-----	-----	-----	-----	-----
-----	4	800-1,000	2	1,800*	-----	-----	14	400-500*	-----	-----
5,100	5	2,000*	-----	-----	-----	-----	9	1,362	41,828	15,621.60
-----	-----	-----	10	1,200	-----	-----	-----	-----	12,000	29,940.80
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
-----	5	400	-----	-----	-----	-----	-----	-----	2,000	9,350.20
-----	61	3,000	4	3,000*	-----	-----	12	1,600	214,200	4,971.20
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	9,324.00
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	22,920.07
-----	18	500*	-----	-----	-----	-----	-----	-----	9,000	9,582.00
-----	5	1,500*	-----	-----	-----	-----	25	35	875	12,714.41
-----	45	850-1,000	-----	-----	-----	-----	-----	-----	7,500	7,015.40
-----	-----	-----	-----	-----	-----	-----	-----	-----	45,000	17,408.40
-----	3	2,300	-----	-----	-----	-----	45	2,000	96,900	4,000.00
-----	-----	-----	75	500	-----	-----	5	250-350	39,000	41,149.80
-----	30	500	10	500	-----	-----	10	100	21,000	27,002.40
-----	35	1,000*	-----	-----	-----	-----	5	500*	37,500	44,898.98
-----	-----	-----	-----	-----	-----	-----	10	1,200	12,000	67,973.60
3,000	25	1,200	-----	-----	-----	-----	20	800	55,000	22,242.40
-----	14	1,500*	-----	-----	-----	-----	250	1,000*	271,000	5,954.01
-----	35	500	-----	-----	-----	-----	-----	-----	17,500	18,000.00
-----	40	500	-----	-----	-----	-----	5	200	21,000	8,093.80
-----	3*	2,100*	-----	-----	-----	-----	8	1,500	18,300	5,973.60
-----	65	1,500	-----	-----	-----	-----	5*	1,000*	102,500	12,000.00
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
-----	30	1,750	-----	-----	-----	-----	15	1,250	58,750	18,976.00
-----	2*	1,800*	-----	-----	-----	-----	3*	1,200*	7,200	1,604.70
-----	5*	1,800*	-----	-----	-----	-----	5*	1,200*	15,000	2,326.70
-----	-----	-----	-----	-----	-----	-----	6	50	300	9,212.40
2,100	-----	-----	-----	-----	-----	-----	8	1,000	12,200	38,565.75
-----	80	1,255	-----	-----	-----	-----	-----	-----	100,400	17,905.55
-----	25	300	30	300	1½	8,800	-----	-----	27,500	73,974.47
-----	15½	1,100	-----	-----	-----	-----	-----	-----	17,050	1,604.60
-----	10*	200	-----	-----	-----	-----	50*	50	4,500	10,648.40
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14,601.90
-----	50	750	5	1,000*	-----	-----	20	600	54,500	49,849.00
-----	-----	-----	-----	-----	-----	-----	50	500*	25,000	14,641.40
-----	9	1,000	-----	-----	-----	-----	-----	-----	9,000	43,624.40
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14,242.80
-----	3	4,200	-----	-----	-----	-----	17	3,200	67,000	7,419.00
-----	1,619½	-----	211	-----	1½	-----	1,290.5	-----	3,199,278	1,690,30

Table V gives a general statement in regard to expenditures on roads during 1914 from all sources and what was accomplished with these expenditures. This table shows that there was a total expenditure from all sources (taxes, bond issues, labor tax, and convict labor) during 1914 of \$5,406,945.18, of which \$2,044,738.28 was the expenditure from all sources except bond issues. There were \$2,422,400 from bond issues, and it is estimated that \$591,080 of free labor and \$460,250 convict labor were used in road work during 1914.

This table also gives the mileage of surfaced and graded road obtained from this expenditure, and shows that during 1914 there were 48 1-6 miles of macadam road constructed at an average cost of \$3,923 per mile; 1,619½ miles of sand-clay or topsoil at an average cost of \$1,180 per mile; 211 miles of gravel road at an average cost of \$2,113 per mile; 15¼ miles of specially surfaced road at an average cost of \$5,150 per mile; 1,290½ miles of road graded at an average cost of \$1,002 per mile.

It is estimated that \$3,199,298 were spent in surfacing and grading these roads during 1914, and \$1,690,307.59 in the maintenance and repair of the dirt and surfaced roads. Cost data, whether for construction or maintenance, have not been kept by any of the counties up to the present time.

TABLE VI

*Statement by Counties and Townships as to Administrative Boards
and Systems of Maintenance*

Column 1 gives the name of the board which controlled road matters during 1914, by counties and townships.

Column 2 gives the manner in which the public roads of the various counties and townships are maintained.

Column 3 gives, by counties, the estimated amount of tax money, value of free labor, etc., used in the maintenance or repair of the public roads during 1914.

Column 4 states whether or not the split-log drag is used in maintenance work, and what other implements were used.

Column 5 gives the sentiment in the county as reported as to use of wide tires.

TABLE VI. ADMINISTRATION AND MAINTENANCE.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money Used in Maintenance in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Alamance.....		County Com.....	Free labor.....	\$ 11,533.98	Not used.....	Nothing said.
Alexander.....		County Road Com.....		10,131.60		
Alleghany.....		County Com.....		9,901.60		
Anson.....	(Balance of Co.) Jonesboro.....	County Com.....	Free labor.....	20,562.40	Used.....	Favorable.
	Morven.....	Township Road Com.....				
Ashe.....		Township Trustees.....		8,020.00	Not used.....	Nothing said.
Avery.....		County Road Com.....		4,508.00		
Beaufort.....		Township Road Com.....		23,659.03	Used in places.....	Slight.
Bertie.....		County Com.....		25,330.98	Used.....	
Bladen.....		County Com.....		3,125.60		
Brunswick.....		Township Road Com.....	Part of original bond issue.....	3,100.40	Used.....	Very little.
Buncombe.....		County Com.....	Free labor and general fund.....	33,764.16	Used.....	Favorable.
Burke.....		County Com.....	Free labor and 20c levy.....	9,075.64	Used.....	Not much.
Cabarrus.....		County Com.....	Road fund.....	29,580.60	Used.....	None.
Caldwell.....		County Com.....	Free labor.....	6,639.40	Used.....	Favorable.
Canden.....		County Com.....		6,060.00	Not used.....	None.
Carteret.....		County Com.....	Special maintenance fund.....	12,587.60	Used.....	Favorable.
	(Balance of Co.) Newport.....	County Com.....				
	Morehead.....	Township Road Com.....	10 cent tax.....	11,412.80	Not used.....	None.
Caswell.....		Township Trustees.....	Balance of tax after interest.....			
Catawba.....		Township Road Com.....	and sinking fund.....	1,222.05	Road machine and drag.....	None.
			Free labor and tax.....	15,924.56	Used.....	Favorable.
Chatham.....		County Road Com.....		10,795.60	Used.....	None.
Cherokee.....		Highway Com.....		5,831.80	Used.....	Not expressed.
Chowan.....		Township Trustees.....		2,313.00	Not used.....	Some.
Clay.....		Township Justices.....		2,852.20	Used somewhat.....	Very much.
Cleveland.....		Township Road Com.....	Tax in each township.....			Growing rapidly.
Columbus.....		County Road Com.....	Special fund and free labor.....	8,775.40	Used.....	

Craven.....	County Com.....	Road tax primarily for maintenance.....	24,577 40	Used.....	Favorable. Considerable. None apparent.
Cumberland	County Com.....	Special fund.....	5,872 00	York State Road	
Currituck	County Com.....	Citizens help at times.....	3,143 60	Hone.....	
Dare.....	County Com.....		3,061 60		
Davidson.....	County Road Com.....		23,717 00	Used.....	Favorable.
Davie.....	County Road Com.....		10,708 13	Used.....	Favorable.
Duplin.....	County Road Com.....		21,604 40	Used.....	Favorable and growing.
Island Creek.		Special fund.....			
Warsaw.....		Special fund.....			
Durham.....	County Com.....	Regular road fund.....	18,123 34	Used.....	Beginning.
Edgecombe.....	County Com.....	Road fund.....	31,882 13	Used.....	Favorable.
Forsyth.....	County Highway Com.....	Road fund.....	28,890 69	Used—one in each township.....	Favorable.
Franklin.....	Township Road Com.....	Convicts are used.....	11,007 20	Not used.....	Some.
Louisburg.....					
Gaston.....	County Com.....	Road tax.....	14,607 00	Steel drags to some extent.....	Some.
Gates.....	Township Road Com.....	Free labor—county furnishes bridges.....	1,796 08		Mentioned.
Graham.....	County Com.....		5,133 00		
Granville.....	County Com.....	Repair forces working all the time.....			
Greene.....	County Com.....		15,894 27	40-50 given out in last 2 years.	Approve.
Guilford.....	County Com.....	General road fund.....	15,155 26	Steel drags.....	None visible.
Halifax.....	Co. Com., Co. Rd. Com.....	Disorganized patch work.....	36,108 00	Used to some extent.....	Favorable.
	Township Road Com.....		40,824 60	Used.....	Some.
	Township Road Com.....				
Harnett.....	County Road Com.....	Free labor.....	10,698 40	Used.....	Some.
Haywood.....	County Com.....		31,874 20		
	Township Road Com.....			Little Winner and a larger machine.....	
Henderson.....	Co. Com., Tp. Trustees.....	Free labor.....	27,584 40	Used.....	None discussed.
Hertford.....	Township Road Com.....	Road fund.....	28,149 00	Used.....	Some.
Hoke.....	County Com.....	Special fund.....	2,969 20	Used.....	None.
Hyde.....		Special tax for 2 tps.....	1,739 29		Law for county.
	Fairfield.....				Favorable.
	Swan Quarter.....				
	Other Townships.....				
Iredell.....	Road Com.....				
	Township Road Com.....				
	County Com.....	Special fund.....	14,651 51	Used.....	Favorable.

TABLE VI—Continued.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money and Value of Free Labor Used in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Jackson		Township Road Trustees	Free labor and special tax	\$17,134.00	Used	None.
Johnston		Township Road Supervisors	Convict force	42,149.24	Used	Very strong.
Jones		Road Com.	Road tax; optional tax	5,478.79	Used	
Lee		County Road Com.	Money left after interest and sinking fund	451.60	Used	Favorable.
Lenoir		County Com.	General fund	38,822.12	Scrapers and heavy steel drags	Favorable.
Lincoln				1,449.20		
McDowell				12,000.00		
	Marion	Township Road Com.	Road tax		Steel drag	Not much.
	Nebo	Township Road Com.	Free labor		Steel drag	Not very much.
	Old Fort	Township Road Com.	Tax		Split-log drag	Favorable.
		Township Trustees	Township tax	17,956.08	Not used	Favorable.
Macon		County Road Com.		9,000.00		Quite favorable.
Madison				16,866.63	Used	Some.
Martin	Robersonville	Township Trustees			Used	Some.
	Williamston	Township Trustees	Raised by taxation	43,419.40	Used	None.
Mecklenburg		Co. Com. and Tp. Trustees		15,400.00	Used	
Mitchell		County Road Com.		21,609.89	Used	Very favorable; special act.
Montgomery		Co. Com. and Tp. Trustees	Part of road fund used			
Moore				15,344.20	Used	Favorable.
	Bensalem	Township Road Com.				
	Greenwood	Township Road Com.				
	Mineral Springs	Township Road Com.	Regular fund used primarily for maintenance		Used all the time	Favorable.
Nash				21,352.60	Not used	Favorable.
	Bailey's Rd. Dist.	Township Road Com.			Used	Not discussed.
	Manning's Rd. D.	Road Com.				
	Rocky Mount Rd. Dist.	Road Com.	General fund		Steel drags	None apparent.

New Hanover.	County Com.	Convicts supported by bond money.	Used	Slight, but growing. Very little.
Northampton	Road Com.		15,621 60	
Oswow	Township Trustees.		29,940 80	Used
Orange	County Com.		9,350 20	
Pamlico	County Com.		4,971 20	
Pasquotank	County Highway Com.	Road fund.	9,324 00	Not used
Pender	County Com.	Patch work by convicts	22,920 07	
Person	County Com.		9,582 00	Used
Pitt	County Com.	General road fund.	12,714 41	Not used
Greenville	Co. Com. and Rd. Com.		7,015 40	Some.
Polk	Highway Com.		17,408 40	None apparent. Some.
Randolph	Co. Com. and Tp. Rd. Com.	Taxes and labor.	4,000 00	Used
Richmond	County Com.	Special fund.	41,149 80	Little consideration. given it.
Robeson	Co. Com. and Tp. Trustees	2% general road fund	27,002 40	Has wide-tire law.
Rockingham	County Com.	General road fund.	44,898 98	
Rowan	County Com.	General road fund.	67,973 60	Used
Rutherford	County Road Com.		22,242 40	Used
Sampson	Road Com.		5,954 01	Used
Scotland	Township Road Com.		18,000 00	Used
Stanly	Township Road Com.		8,093 80	Slight.
Stokes	Township Highway Com.	Free labor	5,973 60	
Surry	Township Road Com.		12,000 00	Used
Swain	Township Road Com.	Road tax fund.	18,976 00	Some.
Transylvania	Road Trustees		1,604 70	Favorable.
Tyrell	Township Overseers		2,326 70	
Union	Township Road Com.	Free labor	9,212 40	Used
Vance	County Road Com.	Taxes	38,565 75	Used
Wake	County Com.	Special fund.	17,905 55	Used
Warren	Co. Com. and Tp. Com.	Taxes and part of bond issue	73,974 47	Favorable.
Washington	County Com.	General fund.	1,604 60	Used with splendid results.
			10,648 40	Used
				Steel drags
				None as yet.

TABLE VI—Continued.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money and Value of Free Labor Used in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Watauga						
Wayne	(Balance of Co.)	County Com.	Free labor	\$14,601.90		None known.
	Goldsboro	County Com.	Free labor	49,849.00	Used	Some.
Wilkes		Township Trustees				
Wilson		Township Supervisors		14,641.40		
		County Com.		43,624.40	Used	Favorable.
Yadkin	Township	Township Road Com.				
		County Com.		14,242.80		Favorable.
Yancey		County Road Com.		7,419.00		

Table VI gives the statement, by counties and townships, as to administrative boards and systems of maintenance. This gives in detail the counties which use the road drag and other implements in the maintenance of roads, and the attitude of the various counties as to the use of wide tires. In this table, also, is stated the kinds of administrative boards in the various counties and townships.

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents. Cloth copies 50 cents extra.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, 50 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, ... pp., ... pl., ... maps. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, ... pp. *Postage .. cents. In press.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-line Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analysis of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, . . pp. *In press.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. *In press.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 75 cents. Cloth-bound copy \$1 extra.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV.—The Birds of North Carolina—*In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, pp. *Postage .. cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 1, 1916.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—There was held at Belhaven, Beaufort County, N. C., on November 29th, 30th, and December 1st, 1915, the Eighth Annual Drainage Convention. This convention was held under the auspices of the North Carolina Drainage Association in coöperation with the North Carolina Geological and Economic Survey. The papers presented at this convention were of great interest, and it is believed that these, together with the discussions in regard to the various phases of the drainage problem, are of great interest and value to the State and those interested in the reclamation and utilization of these swamp and overflowed areas. I therefore recommend that a compilation of these proceedings be published as Economic Paper No. 45 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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PROCEEDINGS

OF THE

EIGHTH ANNUAL DRAINAGE CONVENTION

HELD UNDER THE AUSPICES OF THE

NORTH CAROLINA DRAINAGE ASSOCIATION AND THE NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY

BELHAVEN, N. C., NOVEMBER 29, 30, AND DECEMBER 1, 1915

COMPILED BY

JOSEPH HYDE PRATT, STATE GEOLOGIST
AND MISS H. M. BERRY, SECRETARY

MONDAY, NOVEMBER 29, 1915—Evening Session

The Eighth Annual Convention of the North Carolina Drainage Association was called to order Monday evening, November 29th, at 8 o'clock, in the city hall of Belhaven, by the Secretary, Mr. Joseph Hyde Pratt, the President, Mr. Lawrence Brett, being absent.

MR. PRATT: In calling the Convention to order I want to make the announcement that I am not President of the Association. I am very sorry to say that we have just had a telegram from Mr. Brett, stating that he has been detained at Great Falls, S. C., in connection with some development work he is carrying on for the Southern Power Company. I think this is the first of the eight conventions that Mr. Brett has not been able to attend, and I have been asked to preside in his place.

Tonight I will have to act in the dual capacity of President and Secretary, and for this reason I am going to ask the reporters here to assist as secretaries of this Convention. I am going to call on first, the Mayor of Belhaven, Mr. Tooley.

ADDRESSES OF WELCOME

MR. JOHN G. TOOLEY, for the Town of Belhaven:

Gentlemen of the Convention, Ladies and Gentlemen: I am not mayor of the town of Belhaven, but the privilege of expressing the welcome for the town has fallen to my lot, and, while I deeply appreciate the honor, I feel keenly alive to my inability to do justice to it. Our means in Belhaven for entertainment are rather limited, but our joy at having you with us and having the Convention assemble here is without bounds, and if we can succeed in making you enjoy the occasion as much as we ourselves do, then we will have reached the full measure of success. If there is one thing more

than another that is claiming the attention, and the serious attention, of the people of the State of North Carolina at the present time, it is drainage. The subject is being discussed everywhere; the air is permeated with it and in this section of the country the dogs bark it; the birds sing it; the pines sigh it; and old Pungo River mourns it. It is wonderful to me that so many thousands of acres of land, waste and desolate, with practically no taxable or commercial value, have been, through the successful application of drainage systems, transformed into profitable farm lands. Within a radius of twenty-five miles from where we are tonight there are at least 35,000 acres of swamp lands which have been converted so that they will yield as much per acre as the old farm lands yield. I hope I will be pardoned for relating an incident that occurred last August when a gentleman from Indiana was taken up to a section where thousands of acres of land are stuck in corn. The process is to cut the growth in September, burn it off in May and then stick it in corn, and it produces a yield of from five to fifteen barrels per acre. This gentleman was from the Wabash bottoms of Indiana, which I believe is the best corn section of the country. The land we were going over was a dense forest less than a year previous to his visit and, according to his estimation, it would yield at least eight barrels of corn to the acre. At first he could not let belief take hold of him, but finally he admitted that it was the most marvelous production under the circumstances that he had ever seen. I asked him if he would not, when he returned to Indiana, write the facts and have them published in the *State Farm Journal*. He made this reply: "If I were to do that those people up there would brand me as a notorious liar. The only way they could be made to believe that this land down here is so fertile would be for them to come and see with their own eyes as I have seen." Within a few short months the most gigantic venture ever undertaken in drainage in the State of North Carolina, and perhaps the United States, will be completed and 48,000 acres of lake bottom will be drained and placed on the market at a good value.

Although drainage is in its infancy, the results have added millions of dollars to the wealth of the State, and its people and the personnel of this Convention shows that there are brains behind the movement. The annual mobilization of such forces as we have with us tonight is significantly prophetic of untold good to the State and its people, and I bespeak for the Convention a profitable and enjoyable meeting in the town of Belhaven.

The Chairman then called upon Mr. P. H. Johnson, who made the address of welcome on behalf of the Belhaven Board of Trade.

MR. P. H. JOHNSON, for the Board of Trade of Belhaven:

Mr. President, Ladies and Gentlemen of the Convention: It gives me peculiar pleasure to welcome the North Carolina Drainage Association to Belhaven, for myself, and in behalf of the Board of Trade of this town.

In discussing the land improvement schemes and the immense drainage projects which we have undertaken, it is an invariable custom to speak of the work as being in Belhaven and vicinity, and since my friend Mr. Tooley has said all that could be said for Belhaven, I shall be compelled to enlarge my welcome so as to include the vicinity as well. I am glad to say that I can branch out as far as I like without exceeding the scope of endeavor of your commercial body.

Living in another town as I do, I am at liberty to praise your Board of Trade as much as I desire without seeming unduly boastful or egotistic, and I am glad to say that it is composed of men who early realized that the continued growth and prosperity of your town could only be guaranteed by fostering the development of the country round about it.

Guided by this inspiration, actuated by a desire to see Belhaven take the place among her sister towns to which her splendid location entitles her, these men have worked in an ever widening sphere until they have drawn so distinguished a body as the North Carolina Drainage Association within the circle of their influence.

And now that we have you gentlemen with us, the Board is particularly anxious that something be said that will, to use an old expression, "Haunt you to the place."

They have charged me with a great responsibility and I am sensibly reminded of my incompetence. I am expected to make an appropriate speech, and in a way I have tried to create the impression that I was able to do so. Now it is up to me to tell you all that I am somewhat like an old negro who lived right near Vanderbilt's game preserve at Biltmore.

One evening a game warden drove up to the old negro's house and, without revealing his identity, called out, "Hello, uncle! Have you any game about here?"

"I should say we have, boss," John replied.

"What sort of game have you?"

"Well, we have squirrels and quail, and wild turkeys, and quite often we see a deer."

"Do you ever go hunting?"

"Yes, sir, boss, I went out this morning."

"What did you kill?"

"I killed four squirrels and five partridges, and I went hunting last Monday morning and killed a big deer."

At this statement the game warden produced a pair of handcuffs and, snapping them on the old negro's arms, said: "Come, go with me; you are the man that has been shooting down here. I've been looking for you a long time."

John looked at his bracelets and then looking at the game warden, said: "Boss, you sho is got me dis time, ain't you?"

"Yes, I've got you."

"But, boss, does you know who I is?"

"No, who are you?"

"I'm de biggest liar in North Carolina. I never have been hunting in my life."

I must reluctantly confess that my case is very similar to the old negro's. I have made a good many scattering remarks trying to create the impression that I was able to do more, and now that the Board of Trade has "got" me, I am compelled to own that I never delivered a real speech in my life. However, a man may not be an orator and yet he may be thrilled with an honest pride in his community and a desire for its development, and he may be possessed with that spirit of hospitality which, while unexpressed, will somehow make itself known to the stranger and will inspire him with that secure knowledge of welcome which has immortalized the word "home." We

would have you feel that it is such a spirit which dominates us, and it is such a welcome that we extend to you tonight.

We are particularly glad to have this Convention in Belhaven. You must know that the State Drainage Law very largely had its conception in this community, and while Pantego Drainage District was the third to organize in the State, it really started construction before the law was enacted; and it was perhaps the need which was here emphasized that started the movement that culminated in the organization of the State Drainage Association and the enactment of our present Drainage Law. At that time this district was represented in the Senate by one of our citizens, Hon. F. P. Latham, and we are glad to say that to a very large extent, it was due to the untiring effort which he put forth in its behalf that our Drainage Law was placed upon the statute books in its original form unswayed by the various amendments with which its enemies tried to hamper it.

In view of these facts we cannot but feel that in coming to Belhaven the North Carolina Drainage Association is coming home, and, while we do not wish to imply that you are a prodigal, we do want you to experience the same bountiful welcome which he enjoyed and we trust that your entertainment may be as pleasant as was his participation in the fatted calf of old.

I have watched the State Drainage Association from its very beginning, and while it has encountered many difficulties, I am glad to say that it has always triumphed. I recently read a little poem which ran something like this:

A little cork fell in the path of a whale,
Who lashed it down with his angry tail;
But in spite of his blows it quickly arose,
And floated serenely before his nose.

Said the cork, "You can splutter and splash and flap,
But you never can keep me down.
For I'm made of the stuff which is buoyant enough
To float instead of drown."

I thought how beautifully this little poem described the struggles of the State Drainage Association, and how truly it depicted the reason for its success. Antagonized by big corporations, impeded by learned lawyers, pressed down by hostile influences, it has quickly arisen from the ashes of apparent defeat and continued steadfastly on towards the mark of the high calling whereunto it had aspired because of the fact that it was made of the stuff which would float instead of drown.

There is perhaps no section of the State which has reaped a greater benefit from the labors of these men than has this community. Within a radius of just a few miles we have over a hundred miles of canals cut by dredges serving over one hundred and fifty thousand acres of land, while next door to us is the largest drainage project ever undertaken in this State. I refer to the drainage of Lake Mattamuskeet. We have thousands of acres of land which only a few short years ago were considered worthless, and which now, thanks to the North Carolina Drainage Association, have shown themselves rich beyond the most avaricious dreams of man.

Touched by the magic wand of drainage development tall reeds have given place to taller corn; where once the bear and wildcat held communion with

their mates, blooded stock now graze in peaceful contentment; wild briars have disappeared and roses bloom and flourish in their stead, lading the air with sweet perfume; and deep within the heart of this erstwhile impenetrable wilderness, giant trees which once sheltered the wild things of the forest now stand as mighty sentinels at the gates of men who, even in this short time, have seen that the land was good, have gone forth to possess it, and are now dwelling happily within the shadow of their own vine and fig tree.

I want to say to you gentlemen that the State owes you a debt which it never can repay. You have set in motion a movement, the value of which no man may measure, and I believe that some day your names will go down in history as the foremost workers of your age. I believe that our children will rise up and call you blessed, and that the God of the harvest will pour a bounteous benediction on your heads because of the fact that you have enriched the world by making two blades of grass to grow where only one grew before.

Again I welcome you.

MR. PRATT: I think, for a man who cannot make an address, that the representative of the Board of Trade has done mighty well. One thing he did, though, and that is, he used a little bit of my thunder. I was going to say the same thing about the next speaker that the representative of the Board of Trade has said, and I knew nothing of that story of the Vanderbilt negro.

The next speaker that we will call upon is one who did a great deal for the passage of the North Carolina Drainage Law at the 1909 Session of the General Assembly. He represented this district in the Senate and introduced the bill that became the North Carolina Drainage Law. He did not, like many men who go to the General Assembly, introduce the bill and then forget all about it and leave it to take its own course; but he stayed right behind that bill until it was passed and signed. I take pleasure in introducing to you Honorable F. P. Latham, who will speak to us on behalf of the County Commissioners of Beaufort County.

MR. F. P. LATHAM:

Ladies, Mr. President, and Gentlemen of the North Carolina Drainage Convention: Only a few moments ago, since I came into this hall, was I requested to fill in a gap in the program of arrangements occasioned by the absence of the chairman of our Board of County Commissioners, who was scheduled to welcome you gentlemen of the Eighth Annual Drainage Convention to Beaufort County. I do not feel that I have been given the squarest of deals in thus being thrust into the oratorical company of such gentlemen as have preceded me; they have certainly assembled some appropriate thoughts connected with the purpose of this gathering.

It may not be amiss if I indulge in a little reminiscence of the early history of conditions leading up to the formation of plans for practical drainage on a big scale in North Carolina.

In the summer of 1908 a convention was called to meet at Morehead City for the purpose of devising ways and means to improve drainage that was in use, and to provide some plans to make the vast swamp lands of Eastern North Carolina valuable from an agricultural standpoint. It was attended by a number of the best men of the State who had great public interest in the subject. From a multitude of counsels plans were formulated for the purpose of pressing an act before the ensuing Legislature which would make it possible to form vast areas into drainage districts and bond the lands to pay for the improvements.

I was approached by a gentlemen whom I now see before me, to make a stand, and fight for the nomination to the next General Assembly. After conferences with my friends I made the fight and won, and this with drainage as my purpose. The law as drawn by the committee appointed by the Morehead Convention was intrusted to, and introduced by me; being fortified by the able assistance of such men as Dr. Pratt, Mr. J. O. Wright, Senators Van B. Martin and Oscar L. Clark, the law which is now in operation was ratified practically as first introduced. To you, gentlemen, I say that the selection of this town as your meeting place was entirely fitting. From this very hall twenty-five miles to the west a vast agricultural gold mine is being opened by drainage, twenty-five miles to the north is a continuation of wonderful lands only accessible by a system of drainage, fifty miles to the east the vast agricultural Eldorados have only been tickled on the edges, and they, too, await the beneficial effect of drainage to become a valuable asset to our country.

We welcome you, gentlemen; we welcome any move that tends to hasten the date when these lands will be subjected to cultivation, for when this is done, this town will at once advance to and remain at the head of the list as a stock and grain market of all North Carolina. Now, gentlemen, you will note that every one you meet is interested in drainage; the subject is vital to us. We wish to again welcome you; the long latch string hangs from the outside of every home. Your presence in Beaufort County we know will be profitable to us, and we hope pleasant to you.

RESPONSE TO ADDRESSES OF WELCOME

MR. PRATT:

Ladies and Gentlemen and Members of the Association: It is with a great deal of pleasure that I respond to these most cordial addresses of welcome. It is indeed fitting that we should hold one of the conventions of the North Carolina Drainage Association in the town of Belhaven, Beaufort County, because as one of the speakers has said, the beginning of drainage was really in Beaufort County; and, while the actual cutting of that first canal was not entirely for the purpose of draining swamp lands, but was partly to provide a right of way for a railroad, it did demonstrate and illustrate that drainage of the swamp lands of Eastern North Carolina was a feasible and practicable proposition. This first canal was started just north of here and follows what is now the cut-off of the Norfolk Southern Railroad. That work was done by the Wilkinson Brothers. They were not satisfied with simply digging one canal. They wanted to preach the doctrine of drainage, and they found it such an awfully big proposition that two men could not do all the preaching necessary to inform the people of Eastern North Carolina what the drainage

of the swamp lands meant, and so they called others in; Honorable John H. Small, Congressman from this district; Johnson of Pantego; and Van Martin of Plymouth; and the result was the organization of the North Carolina Drainage Association at a meeting held in New Bern in the fall of 1908.

I can remember the first trip I made down here in Eastern North Carolina in the interest of drainage. I do not know whether I am accustomed to bragging a good deal about North Carolina and the possibilities of certain sections and what North Carolinians can do when they once get started, but I did have the nerve (if you may call it that) to get up in two or three meetings down here in Eastern North Carolina in 1907 and 1908 and state that the swamp lands of North Carolina could be drained and would make good agricultural lands. The first year the only encouragement I got outside the men I mentioned, was from a man representing the Southern Railway, and he stated that if it could be done it would be one of the best things that could happen in Eastern North Carolina. The trouble was he put a lot of emphasis on that word "if." The drainage law was not passed until 1909 and all this work, the drainage of the swamp lands of Eastern North Carolina and the overflowed lands of Piedmont North Carolina, has been done since the year 1909, when the Drainage Law made it possible to organize the drainage districts and carry out the drainage projects. You have in this vicinity approximately 100 miles of drainage canals. How I wish you also had 100 miles of good roads! The two things that will do most for North Carolina, Eastern North Carolina, are the drainage of her swamp lands and the construction of good roads. Now you have here in Beaufort County demonstrated by the actual construction of 100 miles of canals that drainage is feasible, practicable, and profitable; if you will build five miles of good road in Beaufort County, I think you will demonstrate that good roads are also feasible and also very profitable to Beaufort County. Now, taking the two together, with the drainage you have opened up thousands and thousands of acres of the richest land in the United States for cultivation, and with good roads you will make that land accessible to market. Your roads are not now in the condition they should be to attract and interest outsiders to come in here and begin to cultivate the lands that you have drained. I had an inquiry come into the office just before I left, one man wanting a thousand acres of land that is to be drained or land that is drained in Eastern North Carolina. Another inquiry came from a man from the West who is now in Charlotte, who wishes to invest in drained swamp lands. I wonder if you people of Belhaven and Beaufort County realize as I do what you have right here in Beaufort County, with Washington as well as Belhaven as centers. You have here belts that overlap. If you take a map of North Carolina, showing what we call the tobacco belt, the cotton belt, the peanut belt, the truck farming, and the fishing industry, every one of these belts overlaps in portions of Beaufort County. You have more, perhaps, in this general vicinity in natural resources than in any other section of North Carolina. We don't realize what we have right down in this general section.

I want to correct a statement Mr. Johnson made, and that was that the Wabash was the best corn land in the country. I am willing to call that the second best; but the best corn land in the United States is right around here in portions of Beaufort, Hyde, and Tyrrell counties, and in this general belt. I am not the only one who can talk up North Carolina. I think we have that spirit of standing up for the State, and it is spreading right down to the

smaller children. I remember one of the little girls from Chapel Hill who was visiting her aunt in Tennessee. They took her to church on Sunday at which service the minister made a very fervent prayer for rain. It did not rain Monday nor Tuesday; but on Friday it did rain, and at the dinner table her aunt remarked that the minister's prayer had been answered. This little girl piped up and said: "Shucks, that's nothing; in North Carolina when the minister prays for rain on Sunday, it always rains by Tuesday."

Now there is another reason why I am glad we met at Belhaven at this time, and that is that the people who are interested in the drainage work in North Carolina will have an opportunity to visit perhaps the most unique drainage proposition or problem that has ever been taken up in this country. It is not possibly the largest area, as we have a larger one in Florida, but I think you have the most unique drainage proposition in the Lake Mattamuskeet project because the drainage of that district, which, altogether, comprises 120,000 acres, is being done partially by gravity, but the final drainage can only be accomplished by pumping, as the bottom of the lake is several feet lower than the surface of Pamlico Sound. We will have an opportunity to visit that district before it is completed. We will see the installation of the tremendously large pumps that are necessary to take care of the water, some with an intake of six feet. It may be several years, perhaps five, before all these pumps will be needed again to take care of the water that will come from some cloudburst into that drainage basin, but the plant must be ready to take care of the water if we do get a cloudburst, and we will have a chance to see it before all the water is pumped out. We can also see something regarding the quality of the soil of the bottom of the lake because they have diked off a small area which has been planted in corn the past season. That district has been advertised all over the country, and the question that is put up to me constantly is, Will it pay? Will it be a profitable proposition? I leave it to you what I told them.

I can remember the first time I came to Belhaven. It did not look in any way like it does today. I don't think I know of any town in North Carolina that has made a better, more substantial growth than Belhaven, and I believe from what has been said on this platform this evening that its future growth is assured. With the continued growth of these districts in this section, Belhaven is bound to become one of the big markets. I want to see a grain elevator here, as I believe there is no other one thing that would do more to build up Belhaven and Beaufort County than such an elevator. Why couldn't we have one here in North Carolina? I believe it would do more to stimulate the production of corn than perhaps anything we could do. Connect Belhaven with Washington, with Columbia, and with Plymouth by good roads, and you have an outlet to the north. Then, again, there is another thing that will build up Belhaven. I wonder if you ever thought of Belhaven as a winter resort or a summer resort. But after all, the thing that would help to build it up more than anything else is good roads. I believe you have the climate and other things that would make this section attractive not only for winter but for summer visitors, but you cannot build it up that way unless you have a system of better roads so that you can get in and out. Now, I like Chapel Hill, but if I felt I could not get out of Chapel Hill, I would not want to live there. The good roads will do more to build up a section than any other one thing we have.

This year we are bragging about the hundred miles of drainage canals in Beaufort County; next year let's be bragging about nearly a hundred miles of good roads.

I don't want to take up too much time as "Mr. Brett," because I have to talk a little as "Secretary." I will tell you a story in which the word "sufficient" was used which will illustrate what I want. Two Irishmen got into a dispute as to which was the better man, and they decided the only way to settle this was to have a regular fight. They did not want any witnesses, so they decided to get out behind a building and have it out, and the one who was ready to quit first was to holler the word "sufficient." The bigger of the two finally managed to get the other fellow down and kept pounding at him for quite a while, but the other fellow was getting in some good licks, too. Finally the fellow on top yelled "sufficient," and the one on the bottom said, "Thank the Lord. I have been trying to think of that word for the last half hour."

I can assure you that we are, as representatives of various sections of North Carolina, very glad to meet here at Belhaven, and we thank you, gentlemen, for the cordial addresses of welcome that you have made to us, and I know we are going to enjoy every minute that we spend in Belhaven; and that, while at the end of the Convention we will have to go away, it won't be because we will want to go away from this most delightful place.

SECRETARY'S REPORT

Mr. Joseph Hyde Pratt, the Secretary, submitted as his report the published proceedings of the Seventh Annual Drainage Convention. This report was accepted and approved by the Convention.

TREASURER'S REPORT

The report of the Treasurer showed a balance on hand November, 1914, of \$97.99. Receipts during 1915 amounted to \$41, making a total of \$138.99. Expenditures during 1915 amounted to \$118.75, leaving a balance December 1, 1915, of \$20.24.

This report was referred to an auditing committee, composed of Mr. John Wilkinson of Belhaven and Mr. M. W. Thompson of Greensboro.

TUESDAY, NOVEMBER 30, 1915—Morning Session, 9:30 o'clock

MR. PRATT: The First Vice-President of the Association will be presiding officer of this morning's session.

MR. JOHNSON: This is rather a surprise to me. However, those of you who were at Wilson last year probably remember that I told you if you would come to Belhaven we would show you soil richer than you ever saw and a sky bluer than you ever saw, and we would convince you that the farther east you came, the nearer you would come to your Creator. Since it is by the grace of God that we are permitted to assemble again, we will now open the Convention with a prayer by the Reverend Hayes Farrish:

OPENING PRAYER

"Our Father in Heaven, in Thy name and through Thy new and living way that has been opened up to us, even that way that reveals to us the Fatherhood of God and the power of the Creator, we come and approach Thy throne of grace at this hour; and as we come in the interest of this organization and this Association that means so much to the development of the community, to the development of the State and to the advancement of civilization, we cannot but thank Thee that Thou hast impressed upon the hearts and minds that there is music in the running brooks; that there are sermons in the pebbles that are washed by the waters in the earth; and that there is good in everything. We realize that Thou hast given man dominion over the earth. He has grappled the air and controlled it. He has mastered the earth upon which he treads, but there is still a great vast outreach of territory that is not yet completely subjugated to the good of the world. We thank Thee for this Association that contends for the development of the undeveloped. We thank Thee that Thou hast given to the sons of the earth the power to be tillers of the soil. We thank Thee that we can read the story of the earth upon the surface and that we can explore and find the hidden resources thereof. We thank Thee that we can use all of these things for the good of the community; that we can use them for the service of humanity; that we can use them to the glory of God. We thank Thee, our Father, that Thou art not unmindful of Thy children, but revealest to man the objects of nature; and wilt Thou help us to look beneath the rugged undergrowth on the surface and search for the hidden treasures that lie in the pockets of the earth and as we bring forth these treasures to the light, through scientific investigation and experiment, wilt Thou help us to use them to Thy good and Thy glory. Wilt Thou bless the messages that they bring to this community; wilt Thou bless the decisions that shall be made. Wilt Thou bless every effort that is put forth and work that is effected in this gathering, that it may be for the good of humanity and for the advancement of Thy truth. Wilt Thou bless us now while we further deliberate during the hours of these sessions, and use us to some thing and some glorious service, through Jesus Christ, our Lord, Amen."

APPOINTMENT OF COMMITTEES

The Secretary then announced the appointment of the following Committees:

COMMITTEE ON RESOLUTIONS

M. F. H. Gouveneur, <i>Chairman</i>	New Hanover County
Van B. Martin.....	Washington County
Honorable John H. Small.....	Beaufort County
J. A. Wilkinson.....	Beaufort County
E. B. Hopkins.....	Tyrrell County
R. O. Bagley.....	Currituck County
Professor M. E. Sherwin.....	Wake County
W. H. Waters.....	Craven County
J. A. Porter.....	Guilford County
F. B. Daniels.....	Wayne County
W. F. Heckstall	Bertie County
Zeno Moore	Edgecombe County

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

R. E. Snowden, <i>Chairman</i>	Craven County
D. B. McNeill.....	Robeson County
E. D. Spruill.....	Washington County
W. T. Hopkins.....	Washington County
F. K. Borden, Jr.....	Wayne County
F. R. Baker.....	Wake County
M. W. Thompson.....	Guilford County
J. D. Goldsmith.....	Mecklenberg County
J. W. Cooper	Bertie County
C. Van Leuven.....	New Hanover County
J. R. Barnhill.....	Pitt County
M. E. Chappell.....	Hyde County
J. C. Cowley.....	Wilson County

MEMBERSHIP COMMITTEE

George Old, <i>Chairman</i>	Beaufort County
Miss H. M. Berry.....	Orange County
E. S. Askew.....	Bertie County
H. M. Lynde.....	Wake County
J. W. Martin.....	Pitt County
J. L. Phelps.....	Washington County
D. A. Cox.....	Currituck County

LEGISLATIVE COMMITTEE

M. F. H. Gouveneur, <i>Chairman</i>	Wilmington, N. C.
John H. Small.....	Washington, N. C.
W. W. Pierce.....	Goldsboro, N. C.
M. W. Thompson.....	Greensboro, N. C.
A. H. Eller.....	Winston-Salem, N. C.
W. D. Alexander.....	Charlotte, N. C.
Jas. B. Armfield.....	Statesville, N. C.
Lawrence Brett	Wilson, N. C.
P. H. Johnson, President.....	Pantego, N. C.
Joseph Hyde Pratt, Secretary.....	Chapel Hill, N. C.

MISCELLANEOUS BUSINESS

MR. PRATT: There is one notice that I would like to give out, and that is in regard to the death of one of the active members of this Association during the past year. While he did not live in North Carolina, yet he was one of the active members of the North Carolina Drainage Association and was extremely interested in everything that is being done toward the development of Eastern North Carolina. I refer to Mr. B. E. Rice, Land and Industrial Agent of the Norfolk Southern Railway. Out of respect to him and his memory I would like to ask the members of the Convention to rise. (Convention rises.)

I think his work and the interest he took in our Association was a big help to the work in this State. He has attended nearly every Convention held, has taken part in these Conventions, and each time has brought us some word in regard to the railroad he represented and its interest in the drainage work in North Carolina. We miss him at this Convention; we miss his words of advice and suggestions in connection with the future work of the Association.

There is another thing to which I would call your attention. You will notice in the program handed out that there is a list of the Drainage Districts in North Carolina. I wish the members would take that list and go over it, and make any corrections in the way of subtractions or additions necessary to bring it up to date. This is the list that we have in the office of the Geological Survey.

MR. JOHNSON: I am denied the privilege of introducing our next speaker—he so aggressively introduced himself last night in so many capacities. However, I do want to say that no man in North Carolina is so well qualified to discuss our North Carolina Drainage Law as is Dr. Pratt, and no other man in the State has given so much of his time and thought to the furtherance of this drainage movement; and I know without saying anything further, that no one who hears Dr. Pratt speak on our State Drainage Law, who is really interested in drainage, can go away feeling other than that his time has been well spent.

I take pleasure in presenting Dr. Pratt, who will talk to you about the State Drainage Law.

THE NORTH CAROLINA DRAINAGE LAW

By JOSEPH HYDE PRATT, State Geologist

The North Carolina Drainage law was passed by the General Assembly of North Carolina in 1909, and represented a bill that had been worked out very carefully by a committee of the North Carolina Drainage Association, who considered it, at the time they worked for its passage by the General Assembly, as nearly a perfect drainage law as could be drawn at that time. It was

realized, however, after the law had been in operation for some time, that certain amendments were necessary to make it more effective. A committee of the Drainage Association took up the question of amendments, and by the time the General Assembly of 1911 had convened they were ready with a bill which had the endorsement of the Association to be introduced in the General Assembly of 1911. These amendments, together with the original law of 1909, represented the drainage law in operation until 1915. A brief summary of this law to 1915 is something as follows:

When it is desired to start the organization of a drainage district, a majority of the landowners, or those owning three-fifths of the area of the lands to be drained, must file a petition with the clerk of the Superior Court of the county or counties in which the lands lie, setting forth the fact that they wish to drain these lands and that it will be for the public benefit. Then, summons is served upon all the other landowners in the proposed district who did not join in the petition. At the end of a certain number of days, after the service of the summons, the clerk hears the petition, and nothing appearing to the contrary, it is his duty to grant the petition, and to order viewers appointed consisting of one drainage engineer and two freeholders in the proposed drainage district. This board of three viewers is instructed to go upon the lands, to ascertain if there are any lands in the proposed district which ought not to be in the district; if so, to exclude them; if there are any lands which ought to be in and are not; and if so, to include them; whether it is susceptible of drainage and whether or not the public will be benefited. Then they make their report to the clerk of the Superior Court. The clerk advertises that a hearing of the report will be held on a certain day, at which time he either confirms or modifies or rejects the report. Any landowner has the right of appeal from the judgment of the clerk of the Superior Court, either that he is included and ought not to be included, or that he is not included and ought to be, or any other part of the report affecting any substantial right of his property.

Now, after that report is confirmed, and if it is not appealed from, the clerk of the court directs the board of viewers to go upon the lands again, to survey out the boundary lines of the landowners, to go on each tract of land, and to classify it as to benefits; the lands most benefited Class A, the next Class B, the next Class C, and so on. The board of viewers, through the engineer, are required to make the plans for the drainage of those lands and then to estimate the cost of same. After they have completed this work, they again file a report ("final report") with the clerk of the Superior Court. Notice is given to landowners to come in and view the report and make objections if they have any. At the end of that time the clerk hears and considers any objections. He overrules objections or approves them, as the case may be, and after the whole matter is considered he approves it, entirely or in modified form.

Any landowner dissatisfied with the clerk's decision, may appeal to the Superior Court in term time and have the judge pass upon the law and a jury upon the facts; or he can take it up to the Supreme Court, the point being that the rights of each landowner are subserved. When approved, the landowners can appoint three commissioners, and upon their election, the drainage district at once becomes a corporation, these three commissioners become directors of that corporation, and the district is given a name, as

Currituck County Drainage District No. 1. This drainage district has all the powers of any other corporation. The commissioners then prepare to issue the bonds authorized.

These are advertised for sale, but cannot be sold for less than par. The interest and principal of the bonds are levied and collected as regular taxes and the bonds are a lien on the land next to State and county taxes.

The commissioners also advertise for bidders to construct the drainage works in accordance with the plans of the engineer. They enter into a contract with the lowest bidder—the lowest, if there is no reason why they should reject his bid. The contractor enters into a bond for the faithful performance of his work, and then they appoint a superintendent of construction to see that it is carried out. From the proceeds of the bonds, the contractor is paid from time to time for his work, based upon his monthly reports, but ten per cent is withheld to the end, as a guaranty. The commissioners appoint a competent engineer or superintendent to supervise the work of contractors.

Several appeals have been made to the Supreme Court of North Carolina regarding decisions of the lower courts relative to the interpretation of the North Carolina Drainage Law, and in every instance the decision of the Supreme Court has been favorable to the Drainage Law. These decisions have very materially improved the market for the sale of drainage bonds and has really made them gilt-edge securities.

In this connection, I wish to emphasize the absolute necessity that every single detail of the law shall be carried out in regard to the organization of the district and the issuing of the bonds, for upon this will depend the legality and, therefore, the salability of the bonds.

In order to assist in the organization of these drainage districts the North Carolina Geological and Economic Survey has had prepared a set of blank forms that covers each step that should be taken in organizing a district.

The Association has continually urged that no amendments be made to the North Carolina Drainage Law except such as have been approved by it, this Association being made up of the men in North Carolina who are particularly interested in the reclamation of our swamp and overflowed lands.

At the General Assembly of 1915 certain amendments were recommended by the Association, but the General Assembly failed to adopt them. On the other hand, they did adopt amendments which had not been approved by the Association, and in their passage, due to an error in the engrossing clerk's office, a very serious handicap has been placed upon the drainage work of the State. The amendments that were passed are as follows:

AMENDMENTS TO NORTH CAROLINA DRAINAGE LAWS MADE BY LEGISLATURE OF 1915.

CHAPTER 43

AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, RELATING TO DRAINAGE.

The General Assembly of North Carolina do enact:

SECTION 1. That chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine be amended by inserting after the word "land" in line five of section thirty, and before the word "is" the following:

"be of such elevation that the owner cannot secure proper drainage through and over his own land, or if said land."

SEC. 2. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 18th day of February, 1915.

CHAPTER 235

AN ACT TO REPEAL SECTION 14 OF CHAPTER 67 OF THE PUBLIC LAWS OF 1911, RELATING TO ADVANCEMENTS MADE TO DRAINAGE DISTRICTS BY THE STATE TREASURER.

The General Assembly of North Carolina do enact:

SECTION 1. That section fourteen of chapter sixty-seven of the Public Laws of one thousand nine hundred and eleven be and the same is hereby repealed.

SEC. 2. That upon request of the Department of Agriculture the Attorney-General shall bring in the Superior Court of Wake County an action against the drainage commissioners of any drainage district that has failed or may hereafter fail to refund any money advanced by the State Treasurer under the provisions of section fourteen, chapter sixty-seven of the Public Laws of one thousand nine hundred and eleven, the said action to be brought both against the board of drainage commissioners and the bond of the petitioners for the establishment of the district required by section two of chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine.

SEC. 3. This act shall be in effect from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

CHAPTER 238

AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, RELATIVE TO THE DRAINAGE OF SWAMP AND OTHER LANDS.

The General Assembly of North Carolina do enact:

SECTION 1. That section two of chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine be and the same is hereby stricken out and the following substituted and enacted in lieu thereof: "It shall be the further duty of the engineer and viewers to assess the damages claimed by the owners of any land located in such proposed drainage district, and to embrace in such assessment the value of any land actually taken and the injury done to any land not taken, including damage to the growing crops and timber located thereon, as well as all inconveniences suffered by such landowners, on account of such proposed drainage or other improvements. Such damages, when assessed and ascertained, shall be considered separate and apart from any benefits such land might receive because of the proposed improvements, and shall be included in the total cost of such improvements, and collected in the manner provided for the collection of other moneys to defray the costs of said improvements under the provisions of this act, and when so collected shall be paid by the board of drainage commissioners to the person or persons entitled thereto."

SEC. 2. That section sixteen of said act be amended as follows: By inserting between the words "assessed" and "is," in line eight of said section, the words "in the manner provided in section eleven hereof," and between the

words "assessed" and "is," in line eleven of said section, the words "in the manner hereinbefore provided."

SEC. 3. That all laws and clauses of laws in conflict with this act are hereby repealed: *Provided*, the same shall not affect any proceedings now pending for the drainage of any lands under this act.

SEC. 4. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

The error consisted in substituting the word "two" for the word "eleven," so that instead of repealing section 11 of chapter 442 of the Public Laws of 1909, section 2 is apparently repealed. Thus far no case has been taken up to the Supreme Court to determine whether this act would interfere with the organization of a drainage district as outlined above, or would invalidate bonds issued by a district since the passage of this act. It is hoped that in the future the North Carolina Drainage Association can have sufficient influence with and the confidence of the members of the General Assembly, so that they will not pass any amendments to the Drainage Law which are not first approved by the Association.

The recommendations that the Association made to the General Assembly of 1915 are as follows:

AMENDMENTS TO THE NORTH CAROLINA DRAINAGE LAW

(Suggested by the Legislative Committee of the North Carolina Drainage Association to the Legislature of 1915.)

A BILL TO BE ENTITLED AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, ENACTING A GENERAL DRAINAGE LAW AND PROVIDING FOR THE ESTABLISHMENT OF DRAINAGE DISTRICTS, AND THE ACT AMENDATORY THEREOF, BEING CHAPTER 67 OF THE PUBLIC LAWS OF 1911.

The General Assembly of North Carolina do enact:

SECTION 1. That section 14 of chapter 67 of the Public Laws of 1911 be, and the same is hereby repealed, and in lieu thereof the following section shall be substituted:

That the State Treasurer shall pay the compensation and expenses of the Drainage Engineer and his necessary assistants as provided in section 2 of chapter 442 of the Public Laws of one thousand nine hundred and nine, which payment shall be based upon an itemized statement approved by the clerk of the Superior Court before whom the drainage proceedings is pending, and also approved by the State Geologist. Such payment shall be made upon the warrant of the State Auditor out of any money in the treasury not otherwise appropriated. The total amount to be paid by the State Treasurer shall not exceed at any one time the sum of fifteen thousand dollars (\$15,000) after deducting the amounts refunded to the Treasurer from time to time. Before any warrant shall be drawn by the Auditor or payment made by the Treasurer the bond of the petitioners required by section 2 of the said chapter shall be first approved by the Attorney-General. Not more than two thousand

dollars (\$2,000) shall be advanced to any one drainage district. The amount so paid or advanced to any drainage district shall be refunded to the State Treasurer by the board of drainage commissioners out of the first moneys which shall come into their hands from the sale of bonds or otherwise if the district shall be established, or the same shall be refunded by the petitioners or the sureties on their bond in the event the district shall not be established. If the drainage district is established and the board of drainage commissioners shall fail to refund to the State Treasurer such sum or sums as may have been advanced to the district out of the first moneys which shall be paid to the district either from the sale of bonds or otherwise, then each of the members of said board of drainage commissioners shall be guilty of a misdemeanor and be fined or imprisoned at the discretion of the court. As a further remedy the State Treasurer is hereby authorized and directed to institute suit against the board of drainage commissioners in their corporate capacity for the amount so advanced by the State Treasurer. If the district shall not be established, and if the petitioners in the proceeding for the district shall not refund to the State Treasurer the amounts so advanced within sixty days after the court has adjudged against the establishment of the district, then the said Treasurer is authorized and directed to institute suit in the Superior Court of the county in which the district is sought to be established against all the petitioners and the surety or sureties on their bond.

Sec. 2. That section 12 of chapter 442, Public Laws of 1909, be amended by striking out all after the words "construction of the ditch," in line eight, and inserting the following in lieu thereof:

The lands benefited thereby shall be separated into eight classes. The land receiving the highest benefit shall be marked "Class A"; that receiving the next highest benefit, "Class B"; that receiving the next highest benefit, "Class C"; that receiving the next highest benefit, "Class D"; that receiving the next highest benefit, "Class E"; that receiving the next highest benefit, "Class F"; that receiving the next highest benefit, "Class G"; and that receiving the smallest benefit, "Class H."

The lands of any one landowner need not necessarily be all in any one class, but may be in different classes according to benefits received. The number of acres in each class as to each tract of land shall be ascertained and reported, but the boundaries of each class need not be marked on the ground or shown on the map.

It shall be the duty of the engineer and viewers to survey and have prepared a map showing the boundary lines of the district, the boundary lines of each tract of land owned by each person, or several persons jointly, and also to compute and show the number of acres therein and mark the name of the owner on the map. In their report they shall also show the total number of acres owned by each landowner in each class, and the total number of acres benefited thereby computed and shown. The total number of acres in each class in the entire district shall be determined and presented in tabulated form.

The scale of assessment upon the several classes of land returned by the engineer and viewers shall be in the ratio of eight, seven, six, five, four, three, two and one; that is to say, as often as eight mills per acre is assessed against the land in "Class A" seven mills per acre shall be assessed against the land in "Class B," six mills per acre shall be assessed against the land in "Class C," five mills per acre in "Class D," four mills per acre in "Class E," three

mills per acre in "Class F," two mills per acre in "Class G," and one mill per acre in "Class H." This scale shall form the basis of assessments of benefits to lands for drainage purposes.

SEC. 3. The boundaries of lands as surveyed and mapped, the ownership thereof and the classification and assessment thereof as appears upon the assessment roll shall be and remain as of the time when the district was established and the final report of the board of viewers approved by the court. No conveyance or devise of land or devolution by inheritance after the owner thereof has been served with the original summons, either by personal service or by publication, shall affect the status or liability of such land as a part of such drainage district, except as hereinafter provided.

If the owner or owners of any lands included in such district shall, after being served with the original summons, and before the engineer and viewers shall survey and classify the same, convey the whole or part of such lands, then, and in such event, the owner and grantee may file a petition before the clerk of the Superior Court setting forth the facts, with a description of the land conveyed either in part or the entire body of land, and attach a map in duplicate of such land conveyed and such portion, if any, reserved and not conveyed, and praying that the grantee be made a party to the proceeding; whereupon the court may make the grantee a party and shall certify to the engineer and viewers a description of the land so conveyed and copy of the map, with directions to verify the boundaries and classify the said land to the same extent as if the grantee was the original party. Such part of the lands not so conveyed shall be and remain a part of the district.

After the district shall be established, the lands classified and the assessment roll filed, no conveyance of any land in the district shall affect or change the existing status or liability of such lands as to assessment charges or otherwise, except in the manner herein defined. Before any conveyance and delivery of deed, or at any time thereafter, the original owner or owners of land and the grantee or proposed grantee may jointly serve written notice on the chairman of the board of drainage commissioners that on a certain day they will move before the clerk of the Superior Court to amend the final report of the board of viewers and assessment roll, which motion may be based upon a petition and map filed with the clerk. Such petition shall contain a description of the lands in the district claimed by the owner as recited in the final report and assessment roll, and description of the land conveyed, or proposed to be conveyed, the name of the grantee, and such other facts as may be pertinent and shall pray the court to amend the final report of the board of viewers and the assessment roll by adding the name of the grantee as one of the landowners of such district and by amending the assessment roll accordingly. The petitioners shall file with the court at the same time a map showing the entire land of the owner and the part conveyed, or proposed to be conveyed, which map shall be attached to the petition. Copy of the petition and map shall be delivered to the chairman of the board when the notice is served upon him. If the entire body of land claimed by the owner or owners, as appears in the final report and assessment roll, has been conveyed or is proposed to be conveyed, then it shall not be necessary to file a map with the petition, and the court may, after a hearing, make an order amending the final report as to the name of the owner of the land, and substituting the name of the grantee upon the assessment roll. If only a part of the land claimed by the original owner has been conveyed or is proposed to be con-

veyed, as appears by the petition and map, then the court shall make an order referring the petition to the board of drainage commissioners with instructions to verify the description and map and to ascertain in which class or classes the land so conveyed should be placed, and the amount of the tax assessment upon the same during the remaining years for which the bonds or other liability shall be outstanding and the assessments are to be paid, and report their findings to the court. The board of drainage commissioners shall submit their report to the court within twenty days thereafter, unless the time shall be extended by the court. The petitioners may file exceptions to this report within fifteen days after the same shall be filed with the court. At any time after fifteen days from the filing of the report the court shall, after previous notice of five days to the petitioners and the chairman of the board, or their attorney, proceed to consider the report and find the facts and make an order amending the final report, and, also, by adding the name of the grantee or grantees to the assessment roll, under such classification and with such assessment as may be just in the premises. If for any reason the grantee and grantor or the devisee and heirs at law cannot agree upon the terms of a joint petition to the court, the petition may be filed by any one of them, but notice shall be given to the remainder. If the title and ownership of any lands in the district, in whole or in part, shall pass and vest in another person or persons by devise or by inheritance, then, and in such event, such devisees or heirs at law may file their petition in the court and be entitled to all the remedies provided herein. If the ownership and title of more than one tract of land in the district has become vested in other persons, either by grant, devise or inheritance, then all of the new owners may join in a common petition to the court as hereinbefore provided. In no event shall such a change in the classifications or assessment be made as to the land conveyed as shall reduce the aggregate amount assessed against the entire land for each remaining year as appears upon the original assessment roll. The board of drainage commissioners under the direction of the court shall amend the assessment roll and tax levy for the several remaining years as appears from the original assessment rolls by readjusting the assessment against the original owner and by adding the names of the grantees or new owners thereof. The assessment roll may be amended in the body thereof or at the end thereof in the discretion of the court, and in such manner as the court may direct. The notice herein required to be served upon the chairman shall be taken as a notice to the entire board of drainage commissioners and the chairman shall be presumed to be acting for the board under the provisions of this section. The chairman acting for the board shall represent and protect the interests of the drainage district and may appear and answer the petition. If any member of the board of drainage commissioners shall own land in the district and shall convey the same in whole or in part the remaining members of the board may act under this section and, if the chairman or other member shall be the grantor or grantee, then notice may be served upon either of the remaining members of the board. The chairman or the board may employ an engineer or surveyor, if necessary to do so. This section shall apply to land-owners in districts heretofore established in the same manner and to the same effect as to proceedings now pending for the establishment of districts, or hereafter instituted, and shall also apply to conveyances hereafter made.

All necessary costs accruing under this section shall be paid by the petitioners. The procedure as to special proceedings shall apply to this section.

Where the title and ownership of any tract or tracts of land embraced in the district has been changed or vested in another or others by grant, devise or inheritance subsequent to the establishment of the district, the assessment roll may be amended in the following manner, which shall constitute an alternative method. The grantor and grantee or the new owners in whom title has vested by grant, devise or inheritance, and the chairman of the board of drainage commissioners of the district may enter into an agreement setting forth the description of the original land as recited in the assessment roll and the description of the portion thereof which has been conveyed, or a description of that part or parts, the title to which has become vested in new owners by devise or inheritance, also the classification of such lands and the amount of tax assessment against the same vested in the new owner or owners, the tax assessment to be stated for the several remaining years for which assessments were levied in the original assessment roll. Such reclassification and reassessment shall not reduce the aggregate assessments against the original tract of land as appears from the original assessment roll. Such agreement may be presented to the clerk of the Superior Court who shall inquire into the truth of the facts or statements agreed upon and after satisfying himself as to the same, and particularly that the aggregate assessment upon the original tract of land has not been reduced, the said clerk shall make an order directing that the original assessment roll be amended by adding the name of the new owners to each annual assessment roll with the amounts assessed against each, and by amending the assessment against the original owner if he has reserved any part of the land originally held by him. The amendments to the assessment roll may be made either by the chairman of the board of drainage commissioners or by the clerk of the court in the original assessment roll, and may be noted either in the body of the assessment roll or at the end thereof, in the discretion of the chairman or the clerk. After the agreement herein provided has been made and signed by the necessary parties, the chairman of the board of drainage commissioners of the district is authorized to present the same of his own motion to the clerk of the court. Any number of grantors and grantees and new owners of any tract of land in whom title has become vested since the establishment of the district may join in one agreement with the chairman of the board of drainage commissioners, but the facts as to each change of title where the land is held in severalty shall be stated separately. If any grantor or grantee or new owner of land shall be a member of or chairman of the board of drainage commissioners the agreement herein provided may be signed by one of the remaining members of the board.

All proper costs accruing hereunder shall be paid by the grantor or grantee or new owners before the order amending the assessment rolls shall be made by the clerk.

Any amendments to the assessment roll made after September first in any year shall not go into effect or be operative in the hands of the sheriff or tax collector until September first of the succeeding year when the next assessment shall become due and payable.

SEC. 4. That section 19 of chapter 442, Public Laws of 1909, be amended by adding to said section the following:

That in the election of drainage commissioners by owners of land each owner of land shall be entitled to cast the number of votes equaling the number of acres of land owned by him and benefited as appears by the final report

of the viewers. Each landowner may vote for the names of three persons. Immediately after the election of said board of drainage commissioners, and after the members of said board shall be appointed by the clerk, the clerk of the court shall notify each of them in writing to appear at a certain time and place within the county and organize. The members of the board of drainage commissioners so elected and appointed shall serve for a term of four years, and to insure uniformity as to the expiration of their terms of service, their first term of office shall begin on the first day of August. In the year when their term shall expire the clerk of the court shall provide for an election in the manner hereinbefore provided, to be held on the second Monday in July preceding the expiration of their term. The clerk of the court shall keep a record in the drainage record of the date of election, the members elected, and of the beginning and expiration of their term of office. A like record shall be kept of any election to fill vacancies, and the members so elected shall only serve to the expiration of the term of his predecessor.

If for any reason the clerk of the court shall fail to provide for an election of drainage commissioners on the second Monday in July to succeed those whose terms will expire on the 31st day of the same month, the said clerk shall have authority thereafter to provide for such election, and until such election the incumbents shall continue to hold their office as commissioners until their successors are elected, appointed, and qualified. If a vacancy shall occur in the office of any commissioner by death, resignation, or otherwise, the remaining two members are authorized to discharge the necessary duties of the board until the vacancy shall be filled, and if the vacancy shall occur in the office of chairman or secretary, the remaining two members may elect a chairman or secretary to hold until the vacancy in the board shall be filled.

The term of office of all boards of drainage commissioners heretofore elected and appointed, or who may be hereafter elected prior to the second Monday in July, 1915, shall begin on the first day in August, 1915, and serve for four years from such date. Boards of drainage commissioners hereafter elected upon the establishment of drainage districts shall serve from the date of their appointment for four years from the first day of August succeeding their election.

The chairman of the board of drainage commissioners shall receive an annual compensation of seventy-five dollars (\$75) and actual and necessary expenses of travel and subsistence. The remaining two members of the board shall receive a compensation of three dollars (\$3) per day while necessarily engaged upon attendance upon meetings of the board or in the discharge of other necessary duties, and in addition their actual and necessary expenses in attending the meetings of the board. The secretary of the board, if other than a member of the board, shall receive such compensation for work actually performed as may be determined by the board. In drainage districts of unusually large area and requiring greater attention, the chairman of the board may be paid a greater compensation, to be allowed by the clerk of the Superior Court, provided the chairman, or the members of the board, shall file a petition with the clerk setting forth all the facts necessary for the determination of the matter.

SEC. 5. That section 25 of chapter 442 of the Public Laws of 1909, as amended by section 6 of chapter 67 of the Public Laws of 1911, be further amended by adding thereto the following:

That where any public canal established under the provisions of the general drainage law shall intersect any private road or cartway the actual cost of constructing a bridge across said canal at such intersection shall be paid for from the funds of the drainage district and constructed under the supervision of the board of drainage commissioners, but the said bridge shall thereafter be maintained by and at the expense of the owners of the land exercising the use and control of said private road; provided, if the said private road shall be converted into a public highway, the maintenance of said bridge shall devolve upon the board of commissioners of the county or by such other authority as by law shall be required to maintain public highways and bridges.

SEC. 6. That section one thousand seven hundred and ninety-two (1792) of the Revisal of North Carolina, which recites the classes of investments in which guardians, trustees, and others may invest their surplus funds shall be amended by adding after the words "North Carolina," in line five, the following words: "or in drainage bonds duly issued under the provisions of chapter 442 of the Public Laws of 1909"; and that said section shall be further amended by adding after the words "North Carolina" and before the words "shall be," in line eight, the following words: "and such drainage bonds."

That the State Treasurer is authorized to receive drainage bonds issued by drainage districts in North Carolina as deposits from banks, insurance companies, and other corporations required by law to make deposits with the State Treasurer: *Provided*, that the Attorney-General shall have approved the form of said bonds.

SEC. 7. That subdistricts may be formed by owners of land in main districts for the purpose of local or more minute drainage, in the manner provided in chapter 442, Public Laws of 1909, and acts amendatory thereto for the organization of main districts. Such subdistricts shall have the right to use the ditches or canals of the main districts for outlets. The formation of subdistricts shall not operate to release the lands in any subdistrict from the payment of any assessment or levy made prior to the formation of such subdistrict, nor from any assessment which may thereafter be made for the completion and maintenance of the canals in main districts, or for the payment of the principal and interest on any indebtedness incurred by the main district; nor shall it give the subdistrict any claim on the funds of such main district for its local use.

It shall be the duty of the drainage commissioners of the main district to control all matters pertaining to the main district drainage. Drainage commissioners for the subdistricts shall have authority and control over all matters pertaining to drainage within their respective subdistricts, except such work as belongs exclusively to the main district.

SEC. 8. The treasurer of the county and *ex officio* treasurer of the district shall deposit any surplus funds belonging to any drainage district in local banks in the county, and preferably in banks located nearest the said drainage district: *Provided*, the said treasurer shall be satisfied as to the solvency of such bank or banks, and, *Provided further*, that nothing contained in this section shall release the treasurer or the sureties on his bond from any loss accruing by reason of the insolvency of any bank or banks where such funds may be deposited. If the treasurer of the district shall deposit any funds belonging to the district in any bank he shall require the payment of the usual rate of interest paid by such bank upon time deposits.

SEC. 9. That section 12 of chapter 67 of the Public Laws of 1911 be amended by adding thereto the following:

That if, for any reason, the sheriff or tax collector shall fail to advertise and make sale of lands of delinquents on the first Monday of February or on the first Monday of March as above provided, then, and in such event, the said sheriff or tax collector shall advertise and make sale of any lands upon which the assessments shall remain unpaid on the first Monday in April succeeding, and if for any reason he shall fail to advertise and make sale on the first Monday in April, then he shall advertise and make sale of the lands of delinquents on the first Monday in May succeeding.

If any sheriff or tax collector shall fail to comply with the law for the collection of drainage assessments, as herein provided, he shall be guilty of a misdemeanor, and, upon conviction, shall be subject to a fine and imprisonment, in the discretion of the court, and he shall likewise be liable in a civil action for all damages which may accrue either to the board of drainage commissioners or the holder of said bonds, to either or both of which a right of action is given.

That in addition to the two copies of the assessment rolls as provided in the section to which this is amendatory, a third copy of the several assessment rolls shall be prepared and filed with the chairman of the board of drainage commissioners who shall carefully preserve the same.

SEC. 10. That this act shall be in force and effect from and after its ratification.

SUGGESTED AMENDMENT TO THE NORTH CAROLINA DRAINAGE LAW

By HARRY McMULLAN

1. Law should make clear whether when land sold it should be for the tax delinquent for the year *sold* and provide manner in which it shall thereafter be carried on tax books of district.

2. Law should be amended so as not to require interest on bond issue to be collected for a longer period of time prior to first assessment than necessary to pay interest that may accrue. There is a conflict in sec. 34 and sec. 35 as to three years interest to be added to bond issue which should be harmonized.

3. Law should provide for method of apportioning assessments on a tract of land which is subdivided after district is formed.

4. Time may be saved by eliminating the preliminary reports without injuring the interest of any party.

MR. JOHNSON: We have with us today, representatives of some of the banks and bond houses who have bought North Carolina Drainage Bonds, and we would like to hear from them.

MR. W. G. SCOTT of the New First National Bank of Columbus, Ohio:

Mr. Chairman and Gentlemen:—I sincerely regret I did not know that I was to be called upon for a talk, for you will mighty soon discover that I am not a public speaker, and I would like to have prepared something to say to you on the matter of drainage district bonds. I would like to correct one statement made by your good fellow citizens that I am manager of the

New First National Bank; I am merely manager of an adjunct of that institution, known as the Bond Department.

Your Secretary has mentioned a matter which I think is of very great importance to you good people of North Carolina. That is the matter of the security and the comparison of salability between drainage district bonds and general obligation bonds. I am afraid that a good many of you put the blame for the difference in salability upon the bankers and bond dealers. Now, in my opinion, that is not where it belongs. Very few of us buy these issues except where we expect to dispose of them—the ultimate arbiter in this matter is the individual purchaser. I am slightly familiar with the drainage laws and bonds of other states, and I know of no State in the Union where drainage district bonds sell on a parity with direct obligation securities. I think this is very largely brought about by the fact that the formation of drainage districts is a comparatively new thing; and another matter that I think tends to injure them, particularly in districts where drainage work is done in a large way, is the confusion in the public mind between drainage and irrigation. Now it may interest you gentlemen to know that, within the last—well, I will say the last three years, to be absolutely certain—we had occasion to take up with the *Manufacturers' Record* of Baltimore, Md., the fact that they were running their drainage and irrigation securities under the same caption. We took issue with them on that and, since it was brought to their attention, they have changed it. There have been so many frauds perpetrated under the name of irrigation that, while there have been a great many good irrigation projects, we, as an institution, have refused to handle any issues which had the name of "irrigation" attached to them.

There are two States in the Union with which I happen to be familiar, where the drainage work is done by the county, and the bonds become a direct obligation. While these issues have a ready sale, I am free to confess that, even in these States there is a differential between drainage bonds and bonds issued for other purposes. There is not a wide divergence in price, but there is at least a slight difference. In States issuing drainage district bonds—take, for instance, the States of Missouri, Arkansas, Mississippi, Louisiana, and even Texas—perhaps there is not a State in the Union that puts as great a safeguard around its drainage district laws as Texas. You are familiar with the decision of a few years ago, in which a Texas judge handed down a decision that, "In their essential elements drainage districts are no different from school districts." It seems that this is a point toward which you can well work in North Carolina. However, as, even in the State of Texas, drainage district bonds do not sell on a parity with general market issues, you will see that there is a good deal of missionary work and a great deal of constructive work to be done along these lines before you can ever hope to make your drainage district bonds command anywhere near the same price as general obligation issues. One thing that is rather hard for us, where our clients are not familiar with drainage, is the fact that drainage is really reclamation. When you take land that has an exceedingly small commercial value and put a considerable expense into your drainage (it is really reclamation, and that is what they call it in Louisiana) you have put a very heavy bonded indebtedness, in proportion to your assessed valuation. Now you can talk yourselves black in the face about the land values, but when you come to sell these bonds you cannot get people away from the

per cent of bonded indebtedness to the assessed valuation. You can tell about the wonderful value of these lands when reclaimed, but investors will usually come back to the point of beginning, which is a comparison of the bonded indebtedness and actual assessed valuation of the district. I have wondered, many times, if your law permitting the payment of the first three years of interest out of the proceeds of the bond sale, was not a detriment rather than a benefit to your drainage projects. It strikes me that it tends to keep your assessed valuation very low instead of bringing it up to somewhere near the actual value of the lands after the drainage is completed.

My good friend Mr. Small has sent me pictures of some of your wonderful crops here, and I have used them time and time again, but it frequently does not make any change in the attitude of the bond buyer. Only a few weeks ago I was showing these pictures to a prospective customer and he said, "O yes, I know all about North Carolina; the corn looks fine and is growing to a great height, but there are no ears on the stalks." What are you going to do about it? I mean from my point of view. And that is one of the things we are up against, gentlemen.

There is one thing that I think you can do in a definite, tangible way that will be of great benefit to North Carolina drainage district bonds. Now I am not an attorney and only reflect that with which I come in contact and that which I gather, but it seems to me that your laws regulating the drainage districts are too cumbersome. I used the word "cumbersome" as expressed by one of the most widely known firms of bond attorneys in the United States, who stated that on account of the North Carolina drainage law being so "cumbersome" they would not approve a transcript for less than \$250. Take an issue of \$10,000, for instance, and this is 2½ per cent before you are able to do a thing, and is a pretty fair profit for the handling of bonds. We submitted a transcript of a North Carolina drainage district issue to another attorney of national reputation, and he turned it down so cold it made me shiver. I do not know the particulars of your laws, but the Hon. Mr. Small has stated that your drainage acts were, in his opinion, the best that could be done under the existing statutes and, the fact that they have been sustained by your courts shows that they were carefully drawn. I am not here to attempt to tell you how to remedy this, and I assure you, gentlemen, that I am not saying these things to criticize but to bring to you some of the facts with which I have come in contact in a personal way. I was born and raised on a farm; have always been interested in farming, and drainage work interests me tremendously. I think you have wonderful possibilities here in Eastern North Carolina, and am very anxious indeed to see you put your drainage district securities in a position to command a better price. This, of course, will take time and some very careful legislation, but it is certainly possible. As conditions are at present, your bonds are retailed very largely on the strength of the bank or bond house which makes the offering and recommends the securities.

I am, perhaps, more familiar with drainage work in Louisiana than in any other State, because I come more closely in contact with it, and I am mighty glad that I have had the pleasure of coming down here and looking over some of the districts whose bonds our institution has handled, and of course, I am interested in the Lake Mattamuskeet District. This is generally considered a wonderful proposition, and I am exceedingly glad that we are to have an opportunity of inspecting this work tomorrow.

There is one phase of the drainage situation which I mention as a closing thought: that is, do not form drainage districts and put in drainage work more rapidly than you are able to sell the lands of the districts to actual farmers who will cultivate the lands, make the districts productive, and pay taxes from which principal and interest of your drainage district bonds are paid at maturity. There is perhaps nothing more desolate than a drainage district where the work has been completed and the land has not been put in cultivation. The ditches will, of course, deteriorate rapidly under such conditions and weeds will grow to the detriment of the land where productive crops should be raised. I believe you will always find it easier to sell the land of a new district rather than an old one which has been allowed to stand for a few years uncultivated. Not only does this uncultivated territory jeopardize the security of your bond issue, but it also entails an additional expense to the farmer who must clear out the ditches and do over again much of this work, to a greater or less extent, before he can put the land under cultivation. In this matter I am considering this phase of the question, not only from a bond point of view, but also from the standpoint of those who form drainage districts with the expectation of selling out their lands to farmers.

To you good gentlemen who have been reclaiming the wet lands of North Carolina, I wish to express sincere appreciation of your work; and surely there are few better things than the constructive work of turning waste land into very great productiveness and of permanently improving your part of the country.

I think we are all very deeply indebted to Dr. Pratt for the splendid work he has done in connection with the North Carolina Drainage Association, and to the Hon. Mr. Small for the great amount of time and enthusiasm he has put into the matter of your drainage laws. We perhaps take for granted, without due appreciation, the time and energy that these and other gentlemen have put into this work, particularly during the early formative period. May they live long, prosper, and continue their efforts for years to come.

MR. STUBBS: I am such a small banker I feel a delicacy in even expressing a thought. There are two or three suggestions that come to my mind in regard to this matter. I intended to ask Mr. Scott some questions while he was speaking. One question I would like to ask is what effect there is on the bonds if they are paid serially.

MR. SCOTT: I prefer the serial maturity. This obviates the sinking fund necessary in bonds of one maturity and is more economic for the district.

MR. STUBBS: I have had considerable correspondence in regard to the sale of these bonds. If anything could be done to make the organization more simple it would help it wonderfully. I find that even the failure to post some little notice or the smallest proceeding left out will make void a whole bond issue. In the sale of one of the issues of Pungo River bonds, it looked at one time as if the failure to find one copy of the newspaper would make it impossible to sell the bonds. That is one of the principal things that has come under my observation—the time it

takes to organize and the wonderful amount of papers it is necessary to produce in order to make a bond legal. As Mr. Scott says, it is impossible to get a bond attorney to pass on a bond paper except for a very large fee. If it is possible to amend the law in this way, I believe it would help matters considerably. Some houses object to the bonds being serial; they are ultimately placed in the hands of guardians, insurance companies, etc., who prefer their being made payable at a stipulated time instead of in small annual payments.

MR. PRATT: One question I would like to ask Mr. Scott. Ever since we have started the drainage work we have been trying to have the districts as they were organized, instead of being named after some creek or swamp, to be named after the county, as Mecklenburg Drainage District No. 1, Mecklenburg Drainage District No. 2, etc., and I want to ask Mr. Scott whether in his opinion it would not have some effect upon the sale of the bonds to have the districts so named. Suppose a bank had two issues of bonds from a certain county and had a purchaser to come in and buy bonds. Would he not prefer to pay for a bond named Mecklenburg Drainage District No. 1, to Flea Hill Drainage District?

MR. SCOTT: Yes, I think he would, decidedly.

MR. PRATT: I have always thought this and have mentioned it before at the Drainage Conventions. You will note that on this list we have Cabarrus County Drainage Districts Nos. 1, 2, 3, and 4. You will also note that we have Mecklenburg Drainage Districts Nos. 1, 2, 3, and 4, etc. Now, in other places we have a Flea Hill Drainage District, and the Bear Swamp Drainage District, and Buffalo Creek Drainage District. It always seemed to me that if we had two districts and two sets of bonds, and that if I were going to buy them, I would much prefer them to have the name of the county on them.

One other thing I wanted to mention in connection with that, and it is well illustrated in something that happened in Guilford County, and that is, assessed valuation. At the time that Guilford County took up the question of issuing bonds for the construction of public roads they found, as I understand, considerable difficulty in selling the \$300,000 bond issue. The bond buyers came and looked over the county, and they said, "You have not got enough to represent that bond issue. Look at your assessed valuation." The Guilford people said, "We can remedy that," and they went out and put the property considerably higher than before. It was not because they did not have the property—it was because they had assessed it too low.

MR. SCOTT: May I make one suggestion? I rather suspect that one thing which brings that condition about in North Carolina is the fact

that the first three years interest is payable out of the bond sale. If you, as in other States, compel the payment of interest at least by direct taxation during the first three or five years, it might be well. For instance, in Louisiana their bonds must begin maturity in five years. The series can run as long as forty, but the interest is paid by the landowners through a tax. I have wondered if your method has not kept the assessed valuation lower than it ought to be.

MR. PRATT: There is no question but that in any investigation of the land values in North Carolina there is a great big difference in what we say they are worth when we want to sell a bond and what we say they are worth on the tax books. Now, there are two or three sets of people who watch that very closely. If you go to the bank to borrow money, the bank will not take your word for what it is worth. Also, the man who is buying bonds takes a similar view, and also the man who is insuring your property. There is no question to my mind but that if we had our lands assessed at the rate somewhere near their real value it would be a help in selling our bonds the way the land represents the collateral for these bonds. Of course, we have got to keep in mind the results of the improvement to the land. In the beginning this land itself represents the collateral, and that is what the bond dealer looks into as the collateral back of his bonds.

MR. JOHNSON: I just want to emphasize one statement that Dr. Pratt made. In what experience I have had in attempting to sell bonds and in the formation of drainage districts, I have learned by bitter experience that it is not a good plan to try to go too fast; and I fear that proposition is the greatest trouble we have had in selling bonds in North Carolina, which has arisen from the fact that we were not as careful as we should have been. These good people who were charged with the formation of these districts have not adhered as closely to the extreme letter of the law as they should have, and for that reason we have found difficulty in making a sale. I think the most common mistake we make lies in the fact that our land titles are so incomplete in a great many instances that we fail to locate the actual owner of the land, and after we have proceeded for some length of time we finally discover that land was held perhaps by some tenants in common or minor heirs. Then we have to go back and start again; and I believe that in forming these districts in the very beginning we should endeavor to determine the actual owner of every piece of land in that district, make a proper list and find out if there is more than one claimant to one piece of land, and, if so, require that they come before the clerk of the court in answer

to this complaint. If we do this I feel sure we will facilitate the sale of bonds as much as any way we could devise.

MR. C. VAN LEUVEN: The law as it now stands requires that the bonds should mature serially, one-tenth of the whole amount being returned annually. In the case of most districts, especially small ones, this requires that bonds should be issued in \$500 denominations, and in most cases in \$100 denominations. Bonds of small denominations are not readily salable in this class of securities, and they are troublesome and inconvenient for the bond dealer and for the investor. I believe the facts will bear out the statement that "Baby Bonds" in \$100 denominations are purchased by a class of people who want investments in large and well known bond issues, which are listed on the exchanges, and that the class of investors who buy drainage bonds are usually people of more ample means, who do not wish their investments cut up in pieces smaller than \$1,000.

As the Board of Drainage Commissioners own or represent the owners of the greater part of the property in the district, it would seem that no risk would be involved in having the law so worded as to give the Board of Commissioners more discretion in the matter of issuing the bonds. If they do this, they can, even in the case of a small district, having a bond issue of say \$7,500, by a slight change in the maturities, so that it would not be necessary for exactly one-tenth to mature annually, arrange so that no bonds smaller than \$500 would need to be issued. It would seem reasonable also to give the Board of Drainage Commissioners more latitude in the matter of selling bonds, as it may be safely assumed that they will obtain for them the best price possible, whereas under the existing law which requires that the bonds be 6 per cent bonds, and sold at no less than par, it is invariably necessary for the Board of Drainage Commissioners to resort to a subterfuge, in order to get the bonds sold off.

MR. JOHNSON: I would like to ask Mr. Scott one question relative to the collection of the tax. Can you tell me when one man sells a piece of land that has already been listed in his name to another man who is not in the district and who has heretofore had no interest in it, what form of machinery these other laws have to change that assessment so that it will be charged to the ultimate purchaser?

MR. SCOTT: I do not believe I could answer your question in detail. I should think it would have to go through by the same process as the change of the general tax fund.

MR. JOHNSON: In our State we list our taxes once a year. In our Drainage Law the entire taxes are listed for ten years, and so far we have not devised any machinery for changing that list.

DRAINAGE CONTRACTORS

By M. W. THOMPSON of Greensboro

I wish to state that I certainly appreciate your giving the contractors a special place on the program. You usually look at a contractor as a one-sided individual, looking after his own interest entirely; but I have always taken an active interest in connection with every progressive movement in my community, and if I can say anything or do anything to help along the cause of drainage I wish to do so. I have been attending the conventions for the last three years and I have been greatly interested in the work, and there is one phase of the drainage work that has always impressed me: that is the need of better financing.

At the first convention I tried to make a talk on "Drainage Bonds." As soon as I became interested in drainage work I was met with the question of financing the districts; in fact, none of the drainage districts, except two, that we have constructed have been able to finance themselves without calling on the contractor to assist them.

There has never been a district in this State, so far as I know, which has been able to sell its bonds at par, and the law states that the bonds must be sold at par. Now when a district gets to that point of either breaking the law or attempting some subterfuge to get around that particular point in the law, I think it would be well for us to devise some change in the law. I asked the representative of the New First National Bank yesterday if he ever knew of any drainage districts whose bonds at 6 per cent had sold for par, and he stated he did not. I think there should be some change in the law to reduce the embarrassment of the commissioners, if nothing else. I have never given much consideration to the general phases of the law until just a short time ago when I had a letter from an attorney, who is considered the highest authority on drainage law in the country, informing me that he would not consider any more North Carolina drainage issues; that so many difficulties appear on the record it is practically impossible to examine a North Carolina drainage issue without being actually on the ground. Shortly after receiving that letter I started in to see what some of the other states are doing and I find that the Western States have laws which I consider quite superior to the North Carolina law. We could not wonder at that very much, for they have been in drainage work much longer than North Carolina, and Illinois has been doing drainage work for about thirty years. They have met many of the difficulties we are now experiencing and have reached the point where they can proceed much faster than we can here.

Dr. Pratt has referred to the list of forms which have been of immense help to the districts in this State in organizing under our law. I find that in some of the Western States they can actually organize and elect commissioners by going through about four forms. They are organized in a much clearer way, and the securities command a much better price on the market.

I find that this matter of a good drainage law has been taken up in a very complete form by the National Drainage Congress of 1912. They appointed a committee of men of national repute, engineers and attorneys who were familiar with drainage work. They gave a great deal of time and thought to the matter, and the result of their deliberation was the "Model Drainage Law." I have a copy of that law here, and it is far ahead of what we have here in North Carolina in point of simplicity. Under this form the small

landowner is taken better care of and more fairness is shown to the man who objects to the formation of a district; and districts would meet with less opposition, I am sure, as the hearing on the petition and decision is given by the court, not by the clerk, as under our present law. Commissioners are elected at once upon the decision to establish a district, and not after several hearings before a clerk on the details of the plan of construction. All notices are served by publication. More definiteness is given to the collection of the tax and the few forms necessary are made part of the law.

The Model Law has had its provisions passed upon by the Supreme Court judges in the Western States, and the National Drainage Congress recommends it to the Legislatures of the different States. I have not gone through it very thoroughly, but I know in the matter of the formation of the districts, where we have so many provisions to carry out, that it is far superior.

Take the history of our drainage districts: you will find in the list we have here a number that have never reached the point of electing commissioners, and a great many that have never been completed. I think that those who had charge of framing our original law have done admirably. They have furnished the machinery by which a great many districts have been organized, and this State has taken the lead among the Atlantic States to such an extent that they have all copied the North Carolina law, with the exception of Florida; but in the construction of anything as we go along from year to year we gain experience, and I think now, in considering changes to the North Carolina law, that we should give a study to the changes that have been made by States that have been engaged in drainage longer than we have here and take from their experience what would be of material advantage to us.

MR. JOHNSON: We have with us today Mr. E. E. Schooley, representing The A. V. Wills & Sons of St. Louis. Mr. Schooley is in charge of the Lake Mattamuskeet drainage project in Hyde County, the largest drainage project undertaken in North Carolina, and one which is unique in the South.

MR. SCHOOLEY:

Gentlemen of the Convention:—I do not know that I am able to say a great deal, as I have done but very little. I have reorganized out of an old organization a bunch of men who have brought about the excavation of over 300,000,000 yards since the first of March, 1915. We have not completed the work, but we have nearly completed it. We had some maps that I figured on getting on the wall before the Convention started this morning, but, due to the fact that I had to get some grub out to the boys, I did not get around to it.

I find one of the essential things with the contractor is the price. The next thing is the organization. You cannot have one without the other. The third essential thing is first-class machinery. You cannot go out in the woods here and pick up scattered men or any old common ordinary man to work on a dredge. The kind of man that you need I will illustrate with one of mine. His name is Ross and he comes from Indiana. He went on a two-yard machine in the lake a year ago the first of last November. He has never left since that day. I do not suppose that that man has drunk a thimble

full of intoxicant. He is always there and is a real healthy man and gets along well with the other men. You can figure when that man goes out in the morning that he is going to do a day's work. He is going to look after the company's interest because he feels like it. These men are just as much disappointed by not getting a good result as the contractor himself. This man makes it easy for the superintendent and makes a success for the contractor. Another thing that makes it nice for the contractor is to have the coöperation and good feeling of every one in the district. That is another very essential thing, because we are having some little trouble out there now—not very much, however. There are very few people who live in a place like Mattamuskeet Lake, or that live in a place where there is very little drainage carried on, that can realize what a dredge ditch is going to be. When you talk about putting a dredge through your farm, they have an idea that it is going to be a ditch about so wide. When you get in there with your right of way and take a couple of hundred feet wide, that is a different proposition. I believe a good suggestion would be in framing the drainage laws of this State, for the Board of Viewers to estimate the damage that is going to be done where the ditch is going through and pay those men outright for this land; and the feeling against the contractor will be eliminated and a great many times this will eliminate hard feelings between neighbors when they get the coöperation of every one in the district. We had our proposition at one time held up by such a condition. One time we had our foreman ordered off, and we have had lawsuits. The people would go out and curse the men, and they would do everything they could to stop the work and to delay it. We do not have the hearty coöperation of these people now that we had at another part of the district.

The contractor as a rule is one of the best organizers of drainage districts that you can get hold of. If any one wants to know anything about organizing a district the chances are that they will go to a contractor and not to a lawyer. I have had a dozen come to me, and on two occasions I have cited them to people, and the organization of the district has practically started through. When they come to me I generally tell them where to go to get lawyers, and I have been asked a great many different questions and helped start things going as well as I could. I am not familiar with drainage laws, but any one interested in drainage work from the contractor's standpoint will usually keep looking around and proposing this and that, and saying to such and such a fellow what kind of district he should get. He will say, "Well, we have a lot of swamp," and I will say, "Why don't you have it drained?" They will begin to question you about it and talk about it. We like to see these organizations start up. The more we get started the better off we are. The one thing we do want and must have is the price. I think that in the work of the contractor the responsibility or the possibility of a man's doing you a first-class job is one of the main considerations. Do not take altogether the man who says he will do the work for 6 cents per cubic yard. He will probably be the most expensive man you can have. You have to have equipment, and that costs money. You can figure almost always in putting a new machine on almost every job you go on of any consequence. We have four machines on this job out here now. They were all practically new, and we have had some trials and troubles and tribulations as most every contractor will have, but we get a fairly good price and we are going to make some money. That is what we came down here for. We are not

going to make the money here that we figured on. We never do. We have had exceptionally good people on the engineering work here—what I mean by that is, they do not expect impossibilities. We had a fair price here, and I am willing to say this, that there is not any of that ditch dug but what has been dug from one to four feet. If we get the price we can afford to do it right, and we cannot afford to do it in any other way because we have a reputation to maintain in doing first-class work, and we do it.

One of the main things, I think, for the engineers who lay out the districts and the commissioners, and particularly the viewers who get the money for the district, to bear in mind, is that to get good work done you have to pay a good price, and you should have a little money on the side. It don't hurt anything for you to have \$300 or \$400 left when your ditch is finished, because there is nothing undertaken or done but, if it were done again, it could be done to better advantage. Frequently it is better to have the ditch deeper or longer, and if you have the appropriation to do it while the machines are there it can be done to much better advantage than it could at any other time.

I would like to see tile drainage started in here. I have done considerable tile drainage in my time in drainage work, and I have put in some 3-inch drain tile. I presume that I was raised in one of the oldest drainage districts in the United States. Twenty-eight years ago they dug a dredge ditch down what is called Lake Fork, in Illinois, and my father owned a farm in that drainage district and I know something about the kicking against the organization of that drainage district when it began. At that time the lands were worth about \$8 per acre—about eight months ago I refused \$200 per acre for that land. Last year I made 65 bushels of corn to the acre on that land. To give you an idea of how the laws are there, to a certain extent the whole district is under the head of three commissioners, and then each lateral that comes out from the main ditch is a small district in itself. Some people do not care to be under the head of the lateral district. They had an idea that every time a commissioner lets a contract the contractor would make \$10,000 or \$15,000, which is not often the case. My father and some other men in that section formed their own drainage district, dug their own ditch, and maintained it for about twenty-five years. When I got hold of the farm I wanted the tile drain through there. It got to be that every fall you had to pay somebody \$5 or \$10 to clean out the ditch. I went around among the gentlemen who owned land and asked them if they would agree to the tile. Every one in that small drainage area opposed tile drainage because it was going to cost money. I went to the commissioners and told them that I wanted an outlet through that place. It was a waste of land and time to have the open ditch through there, and I convinced them that I was right. We went ahead and took charge of that district and put in tile and increased the price of my land \$25 per acre. We paid a tax on it for maintenance, and now have one of the best drained farm lands in that district.

I would like to see the Drainage Law changed so that the contractor can, when it is desired, take bonds for work at a fair price. I believe it would help you a whole lot in getting your districts through and would be a mighty good thing. I had a proposition some time ago, and I was somewhat unacquainted with that part of the law, so in forming our bid it seemed to me a two-way proposition; it was either a cash proposition or bonds for the work. I told them I would take the bonds and do the work at such a price. My

proposition was to take cash or bonds at 95 cents for the work. That eliminates a lot of work of selling the bonds, because the contractor can sell the bonds if he has many of them to sell, just as well as an attorney who never sold them before, and a great many times the contractor can go through the proceedings and tell you whether the attorneys are going to pass on them or not, and a number of the lawyers cannot because they have not had that experience. I did know of a contract that had to be let a second time in this State because some of the proceedings were not right.

We have a nice little job in Florida, and if you fellows at the convention would come down and see us in Florida we have something there that I think would be of interest to the people of North Carolina as long as they are going to maintain the open ditch proposition. We have a ditch that is four feet wide in the bottom and five feet wide at the top, with a depth of approximately four feet. In regard to the labor, it has got mighty scarce down there. Most of the white men hate to handle the shovel, and the proposition now is to get labor to handle the work. I think we are going to find out by trying different projects on it, and we may not get anything out of it finally, but we are going to get a whole lot of experience. If it will be of any benefit to anybody up here I will try to give some dope on it.

RAILROADS' INTEREST IN THE RECLAMATION OF SWAMP LANDS

MR. JOHNSON: In this connection I want to say that while we have done what we could as individuals and districts for this drainage proposition, we are free to admit that but for the railroads all of this work would come to naught; and it is only fair to the railroads to state that they have heartily coöperated with us in our efforts to reclaim this country, and they have rendered us a very great service in advertising our work and the value of our lands.

We have with us this morning a gentleman who, while he is not just exactly a railroad man, is president of a company which is so closely identified with a railroad that it is pretty hard to tell one from the other. I refer to Mr. C. I. Millard, president of the John L. Roper Lumber Company, and an interested party in the Norfolk Southern Railway Company by virtue of that fact.

We shall be pleased to hear from Mr. Millard.

MR. C. I. MILLARD, of the John L. Roper Lumber Company of Norfolk, Va.:

Mr. Chairman and Gentlemen:—The introduction was not exactly correct. I have nothing to do with the railroads. Drainage is of great importance to the railroad companies, the barge companies, and all who do their business through the canals. Every city whose people have business in these lands, and whose traveling men come into this country to secure orders, benefit by the drainage improvements.

I have received the impression this morning, as I have heard these gentlemen speak, that there was running through the meeting a note of pessimism about the difficulties and troubles connected with the Drainage Law. There is nothing impossible, and nothing worth while can be won without a fight.

There is no trouble about the law which cannot be overcome. When the people understand it, and have the proceedings carefully gone over, the bonds can be sold. They are much better than irrigation bonds, because every irrigation project has been more or less a failure, as they have had to tile-drain their lands at a tremendous cost of \$40 to \$60 per acre. Our lands do not require anything of that sort. Neither do we have the difficulties of climate that are encountered where an irrigation scheme is necessary and where the evaporation is so tremendous that the amount of land which has to be irrigated cannot have a very large area, inasmuch as it requires so much water to meet the demands of the crop. The lands here are rich; every one knows that; and the only thing to be done is to take the water off. The only way to take the water off is to drain it, and the only way to drain it is to form a district. The only way to form a district is to go to work!

MR. G. A. CARDWELL, Agricultural and Immigration Agent of the Atlantic Coast Line Railroad:

Mr. Chairman and Gentlemen of the Convention:—Dr. Pratt has invited me to make a short talk in regard to benefits of drainage from the standpoint of the railroads. In this matter I am unable to separate the interests of the railroads from those of the public at large. The railroads will obtain and enjoy no advantages from drainage that will not accrue to the public. These advantages are numerous and well known, and it is not, therefore, necessary for me to deal with them at this time.

Railroads furnish means of transportation for persons and goods from place to place. They have only one source of revenue, *i. e.*, the sale of transportation.

Touching briefly upon the history of the American railroads: the progressive achievement of the American railroads is the greatest achievement in the world's history. There has been concurrent with it a similar achievement in all branches of industry and general development wherever the railroads have reached. Notwithstanding the fact that for more than four hundred years we reveled in a wealth of natural resources, our agricultural lands, mineral beds, and forests were practically untouched before the advent of the railroad. The first exhaust of a locomotive in this country in August, 1829, ushered in a new era, opened up new opportunities, which grew apace as the means of transportation grew.

Railroads cannot live without traffic; hence, in addition to solicitation departments for the securing of competitive traffic, almost all of the larger lines maintain departments for the encouragement of agriculture, industry, and immigration—in other words, for country building.

The future development of Eastern North Carolina depends largely upon the reclamation of our wet lands and the stumping of our cutover lands. One of the scientists in the Soil Survey of the United States Department of Agriculture, in discussing the truck soils of the Atlantic Coast region, tells us that not 10 per cent of Portsmouth soils (the Portsmouth series usually occupy depressions in the upland portions of the territory along the immediate coast line, and for a distance of approximately fifty miles inland) has been reclaimed and used for agricultural purposes. The usable area of the soils of this series is therefore very great, and the crops which may be grown depend rather upon the adequacy of drainage than upon any other factor aside from transportation facilities. Our great need is more people of an

agricultural type. A systematic immigration campaign is being conducted by the railroads, but we cannot settle people upon wet lands; therefore not only the railroads but all branches of society are vitally interested in drainage.

Bacon says, "There be three things which make a nation great and prosperous: a fertile soil, busy workshops, and easy conveyance of man and goods from place to place." A kind Providence has provided North Carolina with a fertile soil (when properly drained); enterprising business men have established the workshops and factories; and the Atlantic Coast Line is an easy conveyance for man and goods from place to place.

MR. JOHNSON: Referring to Mr. Millard's note of pessimism, I want to say this. I am not sufficiently conversant with the Scriptures to quote verbatim, but I remember that Saint Paul says something like this: He says twice he has been beaten with stripes, and mentions quite a number of persecutions he has undergone, and finally he winds up by saying that after all, brethren, I reckon how the trials and tribulations of these times are hardly worth being compared with the glory that is to be revealed within us; and I think these remarks are peculiarly applicable to our condition. I know we have had a good deal of trouble and I believe our districts, especially the ones organized, have cost more money than they should; but however great the cost may have been, I am certain of the fact that it cannot begin to compare with the benefits we are daily deriving from them. Therefore, while we are together on this occasion and at this time seeking to pick whatever flaws we may in our Drainage Law, the object of this is to enable us to improve it in the future and to help the men who are just starting to steer clear of the difficulties we have encountered. After we leave this Convention, Mr. Millard, all of us are optimists when we speak of drainage in this community. We are only pessimists in this building.

It was announced with regret that Congressman Godwin was unable to attend the Convention.

MR. PRATT: There are a few words that the Secretary would like to say: that is to give the names of the two men I referred to last night as making inquiry for the drained lands. One is Mr. W. C. Moore of Statesville, who is asking for 1,000 acres of swamp land which has been or is about to be drained. The other is Mr. O. E. Schoonover of Charlotte, R. F. D. No. 1. He says, "I have lately moved here from the north and wish to secure a rich farm where I can buy it at first cost as I have sons who will help develop it. Of course, I want some hill land for building location for health's sake, and land, if not drained, that could be drained at not too great cost to me." I do not know what he wants except to get in touch with people down here who have the kind of land referred to, and any of you who want to make such a sale can write to Mr. Schoonover.

TUESDAY, NOVEMBER 30—Afternoon Session

MR. PRATT: We have received thus far invitations from the following cities to hold the 1916 Convention: Raleigh, Greensboro, Creswell, Goldsboro, and Charlotte. These names have been turned over to the Committee on Nominations and Next Meeting Place, and they will decide this matter.

MR. JOHNSON: I want to apologize to the Convention for being a little late. It is a pleasure to me to present our next speaker. Saving Dr. Pratt, I know of no man in North Carolina who has devoted so much time and such a great deal of thought to our Drainage Law as has Mr. Small. I have been associated with him in the formation of the Pantego Drainage District, which was the first district organized in this community. I have been impressed with the careful manner in which he worked out all of the difficulties which we encountered. Since that time I have been a member of two Legislative Committees in connection with Mr. Small. Last year I went to Raleigh and he came down from Washington City, and with Dr. Pratt we spent a day in studying the needed changes in our Drainage Law. After that I came back to Mr. Small's office in Washington, and we spent another day, after which Mr. Small spent, I never will know how much time working on this law. Finally he drafted what I considered a very good Drainage Law, and that draft was submitted to our last General Assembly. For some reason, I never have known why, these amendments were not adopted; and in this connection I want to say that I believe it should be the first duty of every delegate who attends this Convention to impress upon his representative, whether in the Senate or the House, the necessity for adopting the changes which this Association shall recommend to the next General Assembly. I believe that we are in a measure to blame for not securing the legislation that we so much desired. We spent enough time in working out the details and preparing these various amendments, but when it came to securing their adoption on the floor, I believe in a measure our Legislative Committee fell down. —Since the bulk of this drainage work is being done or undertaken in eastern North Carolina, I am persuaded that the representatives from the central and western portions of the State have not a definite idea of the great necessity for these needed changes, and inasmuch as we inspire in the hearts of our representatives from these eastern districts no strong desire to aid us in this work, we cannot hope for the coöperation of these western people. Twice I have been to Raleigh in this connection, and I have discussed this matter with a number of representatives, and have become fully convinced that they did

not understand our problems, and that we need some one there during the entire session who is sufficiently conversant with our conditions to protect us. It is apparent that the lack of such a person in our last General Assembly was fateful to our hopes. We are exceedingly fortunate in that in our Congressman from this district we have such an ardent disciple of drainage. We have a man who, to my certain knowledge, has given this matter a lot of study, a man who has devoted quite a lot of his valuable time to this question. I therefore take great pleasure in presenting as our next speaker the Honorable John H. Small, Congressman from the First District, and I know that all of you who hear him will be both entertained and instructed.

ADDRESS OF HONORABLE JOHN H. SMALL

Mr. President and Gentlemen:—I am grateful to the President for the gracious manner in which he has presented me to you—not that all his compliments are true, but nevertheless that does not diminish the appreciation. I have taken leave of a very busy period to join with you in attendance upon the annual meeting of the North Carolina Drainage Association. Among the many activities of our people at various times leading to different, and yet, let us hope, altogether beneficent results, there is a distinct pleasure always in coöperating with men and women who are engaged in work of a constructive nature. It is so easy to pull down; there is so little virtue in criticizing. We are inclined more or less to minimize public work which is being done either individually or collectively, and the most difficult of all work is that which organizes and builds up and makes ready for the doing of things for the common welfare. Unfortunately men like you who attempt to do things are criticized because the critic is always with us, and perhaps serves a good purpose. You cannot engage in any work which brings you into contact with others and requires you to join with others in doing things, without running counter to the opinions of some one and without being in the way of some one. That seems to be an inevitable law of progress; and yet if there were not men and women who had the faculty of initiative and who were resourceful in providing ways and means for giving force and effect to their initiative the world would stagnate, its industries would dwindle, and the march of progress would cease. This organization stands for one of the constructive measures of great moment to North Carolina. It involves more than the taking of the lands which the God of nature has presented to us, and tickling them and getting crops; it requires that man himself shall do something preliminary in order to put these lands in condition for production, and in that it only typifies another law of life. Life for the individual is one of struggle, and the great Creator seems to have so arranged the material world as to fill it with difficulties in order to place its mysteries beyond the reach of the average man, so that they may be only unlocked by active mental processes, diligence, and industry. And it is true with the individual and with the community that where life is easy, where men are not prompted to diligent labor in order to unlock the mysteries of nature and utilize them, that man himself deteriorates and degenerates. If you want to see a man stand still, make life easy for him. It is a truism

that the boy reared in luxury and idleness never accomplishes anything in life; he is a nonentity. He is simply a neutral quantity cast among the flotsam and jetsam of life, doing nothing for himself or others, and there is added to that a life of unhappiness. So this law, teaching us that we must acquire habits of industry, that we must train our mentality, that we must struggle to bring things to pass, is necessary for human development and for material progress.

I was in a community in Eastern North Carolina not long ago, located on one of our beautiful waterways, and found a community which seemed to be dead. The stream abounded in fish, and all you had to do was to go out and catch them and bring them in for food. The land was fertile. It was evident to the most casual observer that all you had to do was to plant and reap; and yet I think it is about the deadest community in Eastern North Carolina. They had never had imposed upon them the necessity for labor, for indulging in strenuous mental processes in order to obtain a livelihood, and thereby acquire habits, both physical and mental, which would enable them to progress.

On the other hand, some of the most progressive communities in the United States are those to whom nature seems to have been most unkind. Less than a year ago I was in a little community in Massachusetts; there were rocks everywhere. The first duty required of the farmer was to spend weary days picking up the rocks and putting them in piles. Their coal for fuel and power was transported from distant States. There was absolutely nothing produced within miles of that section which could be manufactured, and yet I saw factories operated by water-power, electric power, and steam. I saw beautiful, attractive, happy homes; good roads, good streets, commodious churches and schools—all of the marks of a civilized community—and yet if any man had gone to this community in the first instance and thought he could live an idle, thriftless life, starvation would have soon confronted him. These two illustrate the proposition that man must have the impetus and the incentive of struggle for development, and Nature only yields her best when that kind of man gets behind Nature.

We have down here in Eastern North Carolina fertile lands. Everybody knows that. We have tested some of them. And yet there are hundreds of thousands of acres of these alluvial lands which have been cultivated for a hundred years or more, and today they are inefficiently drained. And the men whose vocations are on the farm, and who have made their homes on these lands, and they and their ancestors have cultivated them all these years, have looked forward with comparative certainty to the immediate future and have been able to say once every three, four, or five years that "excessive rains have drowned our crops," and they will repeat the old, old story, "We had good crops, but they are drowned out." And we have other hundreds of thousands of acres of land just as fertile, some of it more fertile, which during these hundred years we have permitted to remain unreclaimed. We didn't need it. We ought to have put in condition for crop production that which has already been reclaimed; but I take it that the time has now come when there is a demand for additional lands, and the problem which now confronts the owners of these lands and those who wish to purchase them is to drain them and put them in condition for tillage—fruitful, successful cultivation.

I went to my home a little early last night wondering what I could bring to you this evening that would be at all suggestive and practical. I am somewhat of a practical turn of mind myself and strive to give practical advice to others. When we realize certain material conditions should be improved, we cast around to see how it may best be brought about. I remember to have read in a certain paper an article signed "Farmer," opposing the issue of bonds for public roads, and I said that will be my text, and I will read it to you directly.

I was very much interested this morning to hear the discussion from experts in regard to the Drainage Law. It is cumbersome to a certain extent, and it is, to a certain extent, inefficient. Having had something to do with the drafting of the original law, I may say that at that time a difficult situation was presented. It was hard to draft a law which would be sustained by our courts and which would be adapted to legal conditions in North Carolina as they exist by statute and have been built up by our court of appeals. The numerous provisions for giving notice to landowners were predicated upon legal precedents established for many years in North Carolina, which throws around owners of property various and sundry kinds of protection. The fact that this law has in its entirety been sustained by the Supreme Court of North Carolina is evidence at least that it is legal. I think, however, that the time has come when we may properly redraft our law in its entirety, and I believe this Association can do nothing better at this meeting than to appoint a committee, which will work out and report to the next meeting a bill as a substitute for the present law; and if it should be adopted by the next General Assembly, it should simply provide that all drainage districts then existing should be controlled by the former law, and new ones fall under the new law. I think that would be more effective than any attempt to amend the present law. Numerous amendments might be joined with other features of the law; but I think, perhaps, some of the most necessary amendments are basic and involve a repeal of some of the essential features of the existing law. An attempt by the last Legislature to enact one amendment resulted in an error which has caused serious complications. I was very much impressed by the remarks of Mr. Scott, of the New First National Bank of Columbus, Ohio. I have known him for years, most favorably, and as an expert in his position as banker. I was impressed by his statement that bonds must be predicated upon their final purchase and ownership by the investor. I recall when the Pantego Drainage District, to which the President referred, sold its bonds. I venture to say that these bonds are now held by ten, fifteen, and maybe twenty different holders. They bought them from the bank, the original purchaser, and as Mr. Scott has said, the bank bought these bonds for the purpose of selling them. They don't hold the bonds which they purchase; they are simply dealers in bonds. They have a responsibility and represent a position of trust toward the purchasers of these bonds, because if they sold a bond about which there was any difficulty in collecting the interest, it would embarrass the representatives of the bank and render it difficult for them to sell bonds in the future. The bank itself depends upon the expert attorney who examines the bonds as to their legality, and gives his opinion thereon. This expert, and the bank in turn, look to the local attorney, to the drainage commissioners, and to their representatives in the sale of the bonds; and the landowners in the

respective drainage districts should appreciate the exceeding importance of the district being so established that there shall be not only no difficulty but no delay in the payment of the interest and also in the payment of the principal. If one district in Eastern North Carolina, we will say, should make default in the payment of its drainage bonds, it would impair the sale of drainage bonds all over North Carolina. You will hear dealers in bonds say, "We want no bonds from a certain section. We wish no irrigation bonds from a certain State." Because a drainage district of this section has defaulted in the payment of bonds, a distrust has permeated the minds of the buyers of such bonds and they don't want to buy any bonds from these particular States because they know these bonds are held in bad repute by investors. A bond has a reputation just as an individual has a reputation, a section, and a State. And just as every merchant and every business man and every farmer should strive to build up his reputation for fair dealing and honesty, so that his bond and his promise will be of equal value, so ought these public enterprises issuing bonds seek to build up their reputations.

I wish to speak to you about two obstacles to the successful prosecution of these drainage movements and the organization of drainage districts. There are two elements involved in every public activity, whether that activity be the building of schoolhouses, the levying of local school taxes, the issuing of bonds, and the levying of taxes for building good roads, or the organization of drainage districts. First there are the rank and file of those who are interested simply in their own lives and who have no time or inclination or talent for mastering the details of the proposition. All that they ask is that they have wise leadership and that they shall not be brought into any financial or property entanglements. Then there are the leaders of every movement which depends upon the rank and file of the men who engage in any public activity for improvement and progress. The rank and file ought to be intelligent; they ought to be progressive; they ought to have a disposition to coöperate; and they ought to have confidence in those who assume the leadership in the movement.

I said I had a clipping which gave me the text for one class, the rank and file in all these public movements. Here is a man who wrote a letter to a paper about a proposed bond issue for the building of public roads, and here is the argument which he gave against it:

"I don't see why the farmers of County want to vote for something to put more taxes on them, as there is already enough forced on them without voting for more. By the time a poor farmer pays his fertilizer bill and grocery bills and taxes he has not enough left to buy winter clothes for himself and his family. I don't blame the city man for wanting better roads. It will add more to his pleasure in riding seven days to the week with his wife in an automobile. They won't get jolted so bad on a smooth level road, and of course a little more taxes added on his list won't hurt him, as he is going to have his anyhow whether the farmer and his family get anything or not. Now the idea of a country farmer voting to pay more taxes to improve the county roads is ridiculous, as they are all right for him to haul what little produce he can raise to town, and they certainly are good enough to haul all that he is able to bring back from town."

That is a sample of some of the men in the rank and file who are asked to join hands with their neighbors and do something for public betterment. You all recognize the value of good roads. The statement has been expressed thousands of times that good highways are the best index of civilization; that they improve the value of our farm lands; that they make for better schools; that they augment attendance upon our churches and increase their membership; that they enable our people to associate more freely one with another and extend the radius of their travel and intercourse; and that no community or county or State has ever built good roads who doubted their value or the profit in the investment; and yet you have heard what one of our farmer friends said about it. I say that the man in the rank and file who is asked to join in this public movement where coöperation and unity are necessary ought to have intelligence, progressiveness, the disposition to coöperate; and he ought to have confidence. He ought to have intelligence, because that lies at the very beginning of every progressive movement; ignorance begets prejudice, narrowness, and a disposition to harp and criticize. He ought to have progressiveness, because a man who has reached that stage in life and does not look forward to something better, who does not hope that tomorrow, next week, and next year will usher him into a better condition than the present, who is not filled with the inspiration of hope and who is not willing to strive to convert that inspiration into reality—you cannot do much with that sort of man. He is willing to remain in the rut where he has gradually placed himself, and I sometimes think, if it would not be sacrilege to say so, that even the grace of God could not pull him out, because God is not willing to do anything for a man who is not willing to help himself.

He ought to have confidence. This world is built upon confidence. You and I and everybody have dealings with men every day who make a promise to us, direct or implied, and we rely upon it. I have to travel a good deal upon some of the railroads, and whenever I can, in order to save time, I go on the sleeper. I go to bed and sleep with absolute confidence that there is an engineer at the throttle who will conscientiously do his duty to save the train and the lives of his passengers. We do not go through a day, no matter how narrow and restricted our lives may be, that is not actually based upon confidence. Recently a gentleman who happened to live in New York said to me, "There are millions of dollars every day of transactions in this city which are based simply upon faith of man in man," and yet you and I go among our people, and when some proposition is submitted, maybe for local tax for schools, maybe a tax to get revenue to build a schoolhouse, maybe a tax for public roads or bonds for public roads, some proposition to join hands in the organization of a drainage district, and we appeal to a man and tell him about the benefits that will ensue, and what is the first thing that we hear? "Oh, John Smith or Bill Jones, they have some scheme they want to make some money out of." If it is a drainage district, it is some plan to put so much taxes on my land that I will have to give it up. Lack of confidence; confidence in no one! And it even enters the sacred precincts of the churches. You will find a man enrolled in that sacred cause and, when the church wants to engage in some activity, he will be impugning the motives of other good men. So all these public movements must excite among the rank and file of those who make up the great majority a feeling of confidence in the men who lead and who are actively behind the movement.

There is another obstacle, and that rests in the leadership of these movements. It is not a one-sided affair. There is some ground for criticism occasionally of the men who assume the leadership. There are men who seek to be the leaders in many of these public movements who are actuated by selfish motives and purposes; and while we may criticize the ignorant and those lacking in progressiveness and mutual confidence among the rank and file, there are no words of criticism too strong to apply to him who assumes to lead the people in any public movement, and yet is actuated by selfish and unholy motives. "For unto whomsoever much is given, of him shall be much required; and to whom men have committed much, of him they will ask the more."

The men in the community, the men in the county, the men in the State, who by inheritance and training and by travel and reading and study are the more intelligent, who have been able to acquire something of a competence in the way of property, who are looked up to as leaders in their respective communities, they are those who are referred to in the quotation given and from whom much shall be required. Upon too many occasions in North Carolina, when public movements have been initiated along all these lines, which make for public betterment, there have been found men who have forfeited the confidence which has been placed in them and who have sought to utilize that confidence by coining it into personal profit at the expense of the body of men who are reposing confidence in them. It is hard to build up a reputation for integrity and confidence. It takes days and weeks, and sometimes years, while it may be shattered in a day; and one, two, or three men who are participating in a movement and permit themselves to be actuated by selfish motives of aggrandizement at the expense of their neighbors, who repose confidence in them, will destroy for a whole county or even a larger area the confidence of the people in public leadership and make it more difficult in the future to organize any of these public movements.

Gentlemen, in this movement for drainage we can find lawyers of integrity and character and capacity to represent us in the formation of drainage districts; we can find competent, skilled engineers to make the surveys and the plans and the estimates; we can find banks who will buy the bonds in normal times if they are predicated upon proper security; but there are these essentials without which drainage districts cannot be established, and that is that you must have in these communities and in your drainage districts landowners who are men of intelligence, men of progressive spirit, men who have confidence in each other; and you must have leaders who are entitled to the confidence of the landowners who are invited to participate. Without these essentials this great movement will not progress as it ought to progress. Now I know that all this may sound prosaic and you will all say, "Yes, we know this"; and yet, if it is true that the success of this movement is predicated upon it, then we cannot represent it too often and endeavor to find the remedy. We have a great democracy in North Carolina, a great democracy in this republic of ours. No man can be an aristocrat and say what shall be done; no man can order public roads to be built, drainage districts to be established, schoolhouses to be constructed; no man can say that this community shall have the essentials which are necessary to a high degree of civilization. All that can be done is to furnish the law, the machinery, the method by which it may be accomplished; but its success depends upon the

folk in the community, in the county, in the State. We have inaugurated a great movement. I hope the annual conventions of the North Carolina Drainage Association will continue. I see familiar faces here who have attended other conventions. I hope they will continue to attend, and that they will bring other friends who will go into the various sections of North Carolina and preach the doctrine of drainage until this movement, which means so much to our welfare and the promotion of what after all is the greatest industry in the State, that of agriculture, will grow and increase until all of these lands, so fertile and yet unproductive because they are too wet, shall be reclaimed, shall be efficiently drained, and thereby the wealth of North Carolina increase as a result of the activity of this Association.

TILE DRAINAGE PAYS

By H. M. LYNDE, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture

Mr. President and Gentlemen:—Tile Drainage Pays; perhaps a better title would be, "Tile Drainage, an Investment." One traveling over Eastern North Carolina is impressed with the large number of open ditches on nearly every farm, and wonders why drain tile has not been used more extensively. It has been estimated that from five to six million acres of land now in farms in the State are in need of better drainage. Probably not over 6,000 acres of this large area have been thoroughly drained.

The thorough drainage of our farms has too long been neglected. Everybody knows that a field where water stands during any part of the growing season needs drainage, but it is not so generally understood that the productive capacity of many other fields would be greatly increased by the establishment of better drainage conditions. It is essential for the healthy growth of practically all the cultivated crops that the soil occupied by the roots should contain air as well as water. It is therefore safe to say, in general, that any land where the ground water level stands within three feet of the surface for a considerable length of time after a period of heavy rain needs drainage just as much as land that is covered with water.

CAUSES FOR SO LITTLE TILE DRAINAGE

The extent to which tile drainage has been practiced in North Carolina is not such as to bring before its people the far-reaching importance of this form of improvement. Some tile has been laid in the draining of ponds, swales, and springs, and these are the places where tile drainage should begin, but not very many uniform systems have been constructed. In the Middle West, underdrainage is considered the most important requirement for successful agriculture. There is no reason why the installation of tile in the South should not pay returns just as large as in the Middle West where the soil is no better and the climate not as favorable.

Professor Day, of the Ontario Agricultural College, Canada, states, in a publication on drainage, that despite the success of tile drainage systems already constructed in that flat country the installation of tile has not been rapid. From observation and investigation he attributes this moderate growth to four causes, viz.:

1. The great benefits of underdrainage are not generally understood.
2. The lack of knowledge as to how to proceed to install a system.
3. A current impression that tile drainage is too costly.
4. The scarcity of farm labor, particularly of skilled labor.

Now these same reasons doubtless prevail in North Carolina as in Ontario. Perhaps also might be added the unwillingness to try new methods under changed conditions of labor and machinery. On the other hand, perhaps, the man who appreciates the value of tile drainage too often has not the ready capital with which to do the work.

We hope in this discussion today to impress upon you the great results of underdrainage as an investment, assuming that every one here appreciates the benefits to be derived from drainage in general. If you did not you would not be here. Tile drainage is the ideal form of farm drainage. A line of tile in the ground generally drains more thoroughly than an open ditch, especially in clay and loam soils.

SURFACE DITCHES DO POOR WORK

The common surface ditches from an agricultural standpoint are expensive and of low efficiency. They are often not deep enough, their grade is usually poor, and the water flows slowly. In clay and loam soils the percolation is very slow, caused by the sides of the ditch becoming more or less puddled and the soil spaces closed from the flushing of flood flows. The farm, too, is cut into irregular-shaped fields, which interferes with cultivation, and the ditches frequently occupy from 4 to 10 per cent of the planting area on many farms. Because they are in the way, they are often not spaced close enough together to give good results in draining; and furthermore, they have to be cleaned out from year to year. This adds to their expensiveness.

In tile-drained land the water is carried down through the soil and then off, instead of over the surface, thus replenishing the supply of soil moisture, and the physical condition of the soil above the water table is modified and improved. For this reason tile helps the crop to resist drought, making the soil drier in a wet season and wetter in a dry season, especially on clay lands.

ECONOMY OF TILE DRAINAGE

The statement that thorough drainage results in a deeper soil, with the consequent protection against drought, resulting in greater crop yields, has been presented again and again as an argument in favor of underdrainage, and yet seems to have had little influence in increasing the interest in this subject.

Perhaps the best way of showing that tile drainage pays is to consider it from the economic side, the dollars and cents side, by showing the advantage of tile over the open ditch, in the increase of the available planting area, the reduction of cost of farming operations, and the fact that tile requires very little attention, is permanent, and pays for itself in a very few years.

Probably no one who has ever given any thoughtful attention to the subject will question the fact that it pays to tile drain small areas where a single line of tile will do the work, but whether it pays to underdrain where all the land needs draining is a question about which there may be differences of opinion. The first cost of doing this work seems so large, and the lack of

ready capital often is an added discouragement. A responsible farmer can usually borrow money readily for the purposes of buying machinery, fertilizer, cattle, or other things to supply his more or less temporary needs. Why then should he not be able to borrow money for making a permanent improvement? On many farms there could be no better investment than a system of tile drainage properly installed. It is the belief of the writer that money thus used will prove not only one of the safest, but also one of the most profitable investments in many cases.

The open ditch has its place in all drainage work, but for farm drainage, its principal function should be as an outlet for tile drainage.

Every landowner should ask himself at least five questions concerning his drainage, namely:

1. What does it cost to dig a ditch?
2. What does it cost each year to maintain the ditches?
3. How much does tile cost?
4. How much planting area is lost to cultivation because of the ditches?
5. What would be the value of the crops that could be grown on this area?

The cost of construction of an open ditch is heavy. The amount of earth which must be removed is much greater than for underdrains of the same depth. A tile ditch, of course, must be graded carefully, but considering the smaller amount of material removed, the cost to dig a tile ditch ought not to differ materially from that to dig correctly a ditch that is to be kept open.

The cost of keeping an open ditch clear of weeds, silt and other obstructions will probably average in the neighborhood of one cent per linear yard annually, sometimes less and sometimes more. The cost of 4-inch tile at \$25 per thousand feet (this includes freight) is $7\frac{1}{2}$ cents per linear yard. Therefore, since the ditch had to be dug anyway, if tile had been put in, in the first place, it would have paid for itself in seven and one-half years in money saved in keeping the ditch cleaned out, for when put down correctly tile needs no attention except to see that the outlet is not obstructed. The interest on the money if it had not been invested for tile has not been considered in this comparison, but we will endeavor to show presently that the landowner will get a greater return on his investment than if he had put the money in the bank.

If the landowner were to take actual measurements of the width of planting space lost to cultivation by the open ditches on his farm, he would probably find that when the rows parallel the ditch the width would be in the neighborhood of ten or twelve feet, and that when the rows are at right angles to the ditch this width would be between twenty and twenty-five feet. These figures may seem rather large to most of you, but they are the results of actual measurements made on thirty-two ditches in Wayne County, and fairly typical, the speaker believes, of other sections of the State. The more improved the machinery, the wider the space lost to cultivation. Assuming sixteen feet as an average width and multiplying this by the total length of open ditches he would be amazed at the number of acres he does not cultivate.

The above point can probably be best illustrated by taking the case of an actual farm in Eastern Carolina, on which the actual length of open ditches has been obtained by a survey, and which is typical of many farms in that section. It is a productive farm, capable of producing a bale of cotton to the acre. The open ditches drain the land well, because the soil is of a more or

less sandy nature, drainage being necessary because of the flatness of the land with many depressions. The ditches, however, cut the tract up into many small fields. The total area under cultivation is 223 acres, and on this area are about five miles of interior open ditches. Assuming an average width of sixteen feet as lost to cultivation by these ditches, this means an area of over nine acres, or about 4 per cent of the total area of the tract. On this area nine bales of cotton could be grown, which at 10 cents per pound is worth \$450. The actual cost of cultivating this nine acres may be neglected, since it is less trouble to go straight across the land than to turn the team at the open ditch. Neglecting also the slight additional cost in picking the cotton, it may be said that the owner will receive an annual profit of \$450 by installing tile. By an expenditure of \$2,000, about \$9 per acre, which includes the cost of tile, digging a new ditch if necessary, laying and refilling, all the interior open ditches on this tract could be replaced by tile. The crops raised on this redeemed area thus represent an annual return of about 22 per cent on the investment. If the landowner borrowed the money at 6 per cent the loan could be paid back in less than five years, as a result of the increased yield of cotton alone, after which this increased yield is an annual profit for an indefinite time. Furthermore, we have not taken into consideration the cost of cleaning out the open ditches, which at 1 cent per linear yard would be \$88 annually, nor have we considered the decrease in cost of cultivation of the whole area by the use of improved machinery.

The farm just described is typical of many west of here, yet the speaker ventures to say that in this immediate vicinity are farms of a like area which have a greater mileage of open ditches than the one described. With ditches spaced 300 feet apart the actual planting area wasted is over 5 acres in every 100, assuming a width of 16 feet occupied by ditch and bank. If landowners could be induced to look upon tile drainage as a business proposition, and ascertain for themselves whether it will pay to invest money for tile, no doubt more work along this line of agricultural improvement would be done.

COST OF TILE DRAINAGE

What does it actually cost to install a system of tile drainage may well next be considered. There is an impression that tile costs more in North Carolina than in other states. When approached on the subject some landowners will reply, "Yes, I know it is a good thing, but tile costs too much. When it gets as low as in other states I will begin to use it." Except in some of the states of the Middle West the price of tile does not materially differ from that in this State. Furthermore, in the states of the Middle West there is a greater demand for tile, competition is strong, and many small factories have sprung up. Until there is more demand for this product in this State the price will not reduce materially; and as it is at present, it isn't much different from that of large factories making good tile in other states. Let's not wait for the price of tile to get lower, but go right ahead with this most important work, reaping the benefits now.

The actual cost of tile drainage will vary with the cost of the tile and labor, the nature of the soil, and the consequent depth and spacing of the drains. Tile of 4-inch inside diameter will cost \$16 to \$20 per thousand feet at the factory, and often \$25 per thousand delivered at the nearest railway

station. If 4-inch tile costs \$25 per thousand, 5-inch will cost about \$35, 6-inch about \$45, and 8-inch about \$80 per thousand feet, in carload lots. The cost of digging the ditch, laying the tile and refilling ought not to exceed 9 cents per linear yard for a ditch 3 feet deep.

With the above prices and assuming an acre of land to be drained with 4-inch tile, the cost will range from \$16 for tile spaced 150 feet apart to \$40 for tile spaced 60 feet apart. To this cost must be added the cost of larger mains, hauling of tile from depot to farm, and cost of accessories like silt-wells and head-walls. Also add to this the cost of engineering. On lands not requiring a uniform spacing, the cost may be as low as \$8 per acre. In North Carolina, a spacing closer than 60 feet on land used for general field crops makes drainage so costly that it is not recommended except on valuable land. A spacing of 100 feet is giving good results on the Portsmouth soils of the Coastal Plain region, and 150 feet in some sections. For trucking crops a closer spacing is necessary than for general field crops.

COST OF CEMENT TILE

A word about the cost of cement tile. Cement tile, if properly made at a factory, costs about the same as clay tile in this State. One of the arguments made in favor of cement tile is that they can be made right on the farm where they are to be used, and that they can be made cheaper than the cost of clay tile. For this reason men are interested in the subject. However, they should be made well or not at all, using a good, clean, sharp sand, varying in size of particles from fine to coarse, and the mixture should not be leaner than one part of cement to three parts of sand, and they should be thoroughly cured. If made properly, persons who have given the subject attention state that there is probably no profit in selling them at prices lower than the current prices of clay tile. If a man can make them in his spare time on the farm, it will probably be cheaper than buying clay tile.

It is evident, then, that the tile drainage of farm lands is not an inexpensive operation, if one considers only the first cost. The exact knowledge of this cost, however, has little significance unless at the same time a fair idea of the profit to be expected can be had. This we have endeavored to point out. Tile drains, properly installed, are a permanent investment, and almost no maintenance is required. The increase in crops in from six to ten years will usually pay for the cost of drainage, after which this increase is an annual profit for an indefinite time.

There is an impression that our Southern lands are too low in value to justify this seemingly expensive work of tile drainage. It is probably true that at least two-thirds of the area of the State may be termed "waste land." What does this mean in our eastern section? It means that much of the "waste land" is *wet* land. Most of the high places have been settled and cleared, but our richest soils are not yet yielding their full value. The soils which are in need of drainage are in general of much greater fertility than the average soils of the State. With an increase in population there will be an increased demand for land, and as the price increases it will become more and more profitable to underdrain our wet farms. With the high prices that all farm products command today, and the numerous markets available, it seems that it would pay to underdrain all land where there is the slightest chance for failure or partial failure. By underdrainage our so-called "cheap lands" would become the most valuable agricultural lands in North Carolina.

SOME ACTUAL RESULTS OF TILE DRAINAGE

The usefulness and helpfulness of underdrainage is not to be measured by what we *promise* but by what it *performs*. No one is so well qualified to speak of the value of tile drainage as those who have tried it. For the purpose of obtaining data as to the results of tile drainage as farmers have experienced it, we sent out a list of questions to those in the State who have used tile. Perhaps the most effective way of presenting their answers is to quote directly from several of them. Time will not permit us to give very many of the replies. Starting in the western part of the State and coming east we have:

1. *From McDowell County:*

"Land that used to grow bullrushes and saw-grass now is the best land I have, and I would not take \$150 per acre. The land I have drained has more than trebled its yield and almost doubled the value of my farm. My land originally had a great many open ditches that did not properly drain the land, and were in the way of cultivation. Since I put in tile my tenant can easily cultivate one-half more land, and doubles his yield per acre with same cost to cultivate."

Comment: This man began using tile in 1880. He commenced by draining land that was no good as it was, but is now draining land that looked dry enough when the other was wet. He has used four carloads of 3, 4, and 6-inch tile on 22 acres, putting tile where it would do the most good. The 3-inch tile cost him $1\frac{1}{2}$ cents per foot, 4-inch tile 2 cents per foot. The labor for installing the tile he estimates at about the same cost as the tile itself. The total cost was probably \$35 to \$40 per acre.

2. *From Guilford County:*

"My farm is fine sand formation, very level for this section of country, and is known as what is termed wet land, viz., there are quite a lot of spouty places, and it takes a long time to dry out so we can cultivate after rains. I bought this place six years ago for \$1,900. Cut some open ditches first year; second year cut quite a lot of lateral ditches and put in poles and slabs. This did well for the crops, but is bad to get clogged up. Then I and two neighbors formed a copartnership and bought a machine to make cement tile, and we have been making tile, ditching, etc., every spare time since, and shall continue until the job is complete. In 1913 our crop was worth more than we paid for the farm, and some eight weeks ago we refused \$5,000 for it. So you see I am an underdrainage enthusiast. Our last two crops averaged about 50 bushels in 1913 and 35 in 1914."

Comment: Increase in crop values average about 300 per cent; increase in assessed value of land, about 40 per cent; selling price of land increased 300 per cent.

3. *From New Hanover County:*

"I began using tile drainage 20 years ago, putting it in the wettest places first and extending the system as I could. Now have my whole farm of 40 acres tiled. The cost of tile per acre has varied from \$18 to \$25, owing to the cost of labor, etc. With truck crops, it has fully paid for itself in one year. I am sure that my success has been due to tile drainage. It is the extreme wet or dry years that prices are best. A good crop where others fail means good money for that crop. Tile helps in a dry season. While we have had

the driest summer (twelve weeks without rainfall enough to wet the ground an inch) in the history of the country, I have tilled land that will harvest 50 bushels of corn to the acre."

4. *From Beaufort County:*

"Crop values have increased one-fourth because of tiling. Land of same character with open ditches worth about \$75 per acre. My tilled land would go readily for \$150 per acre."

Comment: This man began installing tile in 1895, and now has his whole farm of 120 acres underdrained with 35,000 feet of tile. All the old open ditches have been replaced by tile. From data obtained the average cost was about \$10 per acre. As a result of installing tile and doing away with open ditches, he states with regard to the cost of farming operations, "With one-half the men as before and same teams can cultivate oftener, as we use improved machinery."

So we might continue. The above experiences as well as others received are interesting and convincing, and it is hoped that they will convince others that "Tile Drainage Pays."

A TILE DRAINAGE ACT

How can more interest be stimulated in underdrainage? It has been intimated that possibly the large first cost of the work and the lack of ready capital at the disposal of the farmers has had something to do with the slow progress in this field. If it were easy to obtain money for this character of work it is believed more along this line could be done. Unquestionably tile drainage improves the producing power of farm land. Increased producing power means increased farm land values, and increased farm land values always result in an increase of land values generally, in the immediate community. To the municipality or political subdivision in which such lands may be situated in the end come increased taxes. It seems, therefore, that the political subdivision should offer its assistance to bring about this increase in revenue. From experiences of municipalities which have recognized the desirability of promoting the drainage of their agricultural lands, valuable suggestions can be gained.

In the province of Ontario, Canada, there has been in force since 1897 a Tile Drainage Act which enables the council of a town, village, or township to pass by-laws whereby it can borrow money for tile drainage purposes in sums not less than \$2,000 and not exceeding \$10,000, and issue therefor debentures to the municipality in sums of \$100, payable within twenty years and bearing interest at the rate of 4 per cent per annum. To meet the increased demands on the townships for loans, in 1914 the limit of their borrowing capacity was raised by legislative enactment to \$40,000. A person desiring to borrow money for tile drainage may, under this act, do so by making application to the council for a sum not exceeding \$1,000 and not in excess of 75 per cent of the cost of the drains to be installed. The council collects for a term of twenty years from the landowner who borrowed the money a special annual rate of \$7.36 for each \$100 loaned. The drainage work must be approved by an inspector employed by the council before the money is loaned. In 1909 the State of Vermont enacted a law similar to the Ontario Tile Drainage Act whereby the landowner is able to borrow money for tile drainage and repay it to the municipality in twenty equal annual payments. From reports received by the United States Department of Agriculture it

appears that the farmers of Ontario are freely availing themselves of the loan privileges provided by the law of that province, and no failures to promptly make annual payments have been reported. The experience of Vermont with her Tile Drainage Act has not been so successful. In fact no obligations have been incurred under the act. Shortly after the passage of the law the Commissioner of Agriculture communicated with a number of bond houses to ascertain whether they would purchase debentures issued by the municipalities in accordance with the act, but as the law does not make the debentures an obligation against the entire municipality, none of the houses were willing to buy the bonds on a 4 per cent basis.

The thought has occurred to the speaker that if a law similar to the ones described could be enacted in North Carolina impetus and encouragement would be given to the important work of tile drainage on farm lands, and the expert supervision which the law would provide for should insure the quality of the work. Until the passage of the State Drainage Law for the drainage of our swamp and overflowed lands, no great advance was made in the drainage of these large areas. Since its passage we all know what has been accomplished. If such a law has worked such a transformation in our large swamp areas, why should not a tile drainage act help to do the same thing for our wet farms?

The experience of Vermont, however, suggests the necessity for caution if any attempt is made to secure legislation with a view to extending financial aid to farmers wishing to undertake tile drainage. Those who attempt to draft such a law should remember that what may be constitutional in Canada might not be constitutional in North Carolina, and that the financial standing of Canadian municipalities has been regarded rather highly for some time.

SUMMARY

The speaker has endeavored to show how little tile drainage work has been done in North Carolina, and some probable causes for this slow progress. The economy of tile drainage and its superiority over open ditch drainage on our farms has been described, followed by a discussion of the actual cost of tile drainage. Some actual results of tile drainage as farmers have experienced it have been given, and their statements ought to speak louder than any theoretical discussion of the subject. Lastly, there has been included a suggestion indicating the desirability of having a law enacted which will make it possible to finance tile drainage on a larger scale.

Our Southern lands are not too low in value for tile drainage. The use of modern machinery demands it. As the *Progressive Farmer* stated several years ago, "*Let us have better land and bigger fields next year.*"

TILE DRAINAGE AND TILE DRAINAGE FAILURES

By F. R. BAKER, of the North Carolina Department of Agriculture

In studying the different subdivisions of drainage, I sometimes ask the question, which is the most important—whether drainage of wet lands by means of open ditches and underground systems, or whether drainage of hillsides by means of terraces, commands first place. If our Convention were composed of nothing but Piedmont farmers, I would not hesitate in laying stress on drainage by terracing; but yet if I were speaking to an audience

in the eastern section, I would most likely select the subject of drainage by means of canals or by underground methods. But today, being at a Convention whose membership covers the entire State, the question of the most important subject is a debatable one.

It is the prevalent opinion that drainage of the swamp lands in the State is relatively of much less importance to our agricultural interest than is the proper drainage of the millions of acres already under cultivation.

It should be understood that the situation of the upland is more critical than that of the swamp land. The latter is wet throughout the entire year, and it can be dealt with with no uncertainty. On the other hand, the upland is intermittently wet or dry at one time or another, introducing a state of uncertainty which makes the problem of proper handling and cropping a serious matter. The upland suffers from the extremes of moisture conditions, and extremes are always more serious than constant dampness or constant dryness.

Poorly drained farm land, as exists generally throughout eastern and central North Carolina, is usually too wet in the spring and too dry in the summer; consequently there is a resulting poor crop. The roots of crops planted on such land develop very slowly and cannot penetrate deeply into the soil, due to the high water level in the spring; and later on in the season, during drought periods, the water level drops quickly, leaving the roots high and dry to suffer accordingly. If we concede, then, that underdrainage is more important and reaches the needs of more individuals, it should be decided which form of underdrainage meets best the increasing needs of modern conditions.

Underdrainage in North Carolina dates back many years. Poles, boxes, and stones were first used, but as they would easily rot or become filled with sediment, something better and more permanent was sought. Clay tile of different shapes and sizes was then introduced on several farms. This was about fifty years ago. This tile gave gratifying results, as is evidenced by the fact that the early users are the most enthusiastic supporters of tile drainage today. Therefore, after this long experience and further study, it is now generally conceded that the round tile is best adapted for farming purposes, and good practice has abandoned the use of tile less than four inches in diameter.

Yet, despite the successes, tile drainage has spread slowly. Even if we were to overlook the many beneficial results obtained from using it, and if there is no difference in the actual plant growth on undrained areas, there is still a large element of loss in the farming operations, due to the fact that crops cannot be seeded at the same time. They do not mature at the same time, and consequently all operations are upset, which means loss of labor, greater expense, and much inconvenience.

Probably the greatest argument in favor of underdrainage is the elimination of the open ditch on planted areas, and on the other hand the greatest argument against underdrainage is that the increased crop yields make an increase in the expense of gathering or harvesting.

I will not go further into the benefits of tile drainage, as Mr. Lynde has taken up this phase of the subject in detail; but having the bright side presented, I feel that the discussion will be incomplete without pointing out the dangers to which the users of tile are liable if careless systems are in-

stalled. I refer to the subject of tile drainage failures. Why do they fail? and what is the extent of its influence on the future use of tile drainage operations? This is a subject that requires much study and investigation before all of the causes of failure can be determined.

Many thousands of dollars have been wasted in underdrainage because it was undertaken without an adequate understanding of the subject and without a knowledge of the imperative demand for utmost care in every detail. The purchase of so many tile, the digging of a ditch, and the laying and filling of these tile are far from having an effective tile drainage system.

On the other hand, one must be able to select the right kind of tile; know how to dig a ditch to proper grade; understand how to lay these tile; and last, but not least, how to back-fill the ditch. Some knowledge of each factor is necessary if a permanent investment is sought.

It is true that many shiftless and careless systems have been installed and are continuing to work, which to me seems strange, but it is safe to say that the majority of such cases end in failure. Not many days ago a first-class farmer had to take up over 2,500 feet of tile. The result has been a big loss of time, tile, and money, and the necessity of doing the work all over again. The greatest lesson that this man learned was what he should have known before attempting to lay the first joint.

Now the serious question is, what influence will these failures have on neighbors who are contemplating similar drainage?

How many appreciate the relative value of an efficient outlet for a tile drainage system? A good outlet is necessary, one that will take away the water freely after it leaves the tile. If it is allowed to become filled with weeds and sand, thus interfering with the free movement of the water, the results will probably end in failure.

How many appreciate the necessity of protecting the mouth of the tile? Destroy it, and the entire system is in danger. This last joint is the most important one in the entire system. Consider for a moment the dangers to which it is exposed. Weeds and other rank growths are allowed to choke it. Stock often trample on it and break it off. Sometimes it is undermined by water and disjointed. Small animals and insects will enter the mouth of the tile and stop up the drain. A certain gentleman went down to his tile outlet to see how it was working after a hard rain. He was just in time to see a muskrat nest float out, and was indeed fortunate in having it come out at all.

The best way of overcoming these troubles is to support the ends of the tile by a simple head-wall and place a wire screen over the mouth. The head-wall can be built out of large stones, concrete, or brick. Since corrugated culverts have come into use, it would seem that a long joint of this would serve well as an outlet.

Other important factors lending their influence to cause tile drainage failures are improper grades, poor laying of tile, broken joints in the system, and improper material to cover the tile. Yet such avoidable failures as these have caused many to turn against the use of tile on the farm.

The problem then, as I see it, is an educational one: to teach the proper methods of installing systems so that the initial cost will be the whole charge for a permanent investment.

DISCUSSION OF THE GENERAL SUBJECT OF TILE DRAINAGE

MR. PRATT: Last year when we were at Wilson we were very fortunate in having the opportunity of being taken out where we had a practical demonstration in connection with the laying of tile on one of the farms in that section. This was laid by one of the best experts we have in this section of the country.

A DELEGATE: How would it do to appoint a committee to take up a tile drainage law? I make a motion that it be referred to the Legislative Committee, and that the subject of tile drainage be referred to this committee.

MR. PRATT: A motion has been made and seconded that the Legislative Committee take up also during the coming year the question of a tile drainage law and to report to the Convention when it meets in 1916.

Motion passed.

THE WORK OF THE DRAINAGE DIVISION OF THE NORTH CAROLINA
DEPARTMENT OF AGRICULTURE

By F. R. BAKER, Drainage Engineer, North Carolina Department of Agriculture

The North Carolina Drainage Association is now passing through its eighth year. It has accomplished many things. The valuable law by which drainage problems can be solved is probably its most important work. Through this law, many drainage districts have been organized and thousands of acres of land have been reclaimed. In fact there can be seen a marked increase in the interest in drainage from year to year, and I will endeavor to tell briefly what part the Drainage Division has played in attempting to help spread this interest.

Realizing the importance of drainage in agricultural work, there was formed a coöperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture for the promotion of agricultural development along drainage lines, with particular attention to farm drainage. It represents the recognition of a widespread need for improvement in our agricultural production, and we believe that the North Carolina Drainage Association was a leading factor in its establishment. It is therefore a coördinating force with this Association, and we believe that it is well for all forces with common cause to work together.

The purpose of the drainage office is to assist farmers in the draining of their lands, by advice and by investigations of the principles involved. We are prepared to examine their lands, develop a plan of drainage, and give an estimate of cost. We are trying to conduct the work along educational lines, introducing correct principles and methods in different sections of the State, so that enthusiasm for drainage will grow.

Our work may be classified under the following heads:

1. Improvement of Farm Lands now Under Cultivation.
2. Investigations of the Drainage of Swamp Lands.
3. Collection of General and Technical Data on Drainage.
4. Preliminary and Reconnoissance Work.

Considerable interest is being shown in tile drainage and terracing throughout the State. Thirty-nine examinations have been made for tile drainage systems scattered over twelve or more counties and comprising an area of over 2,000 acres. On this area over 65,000 feet of tile ditches were staked off. Fourteen examinations were also made for terrace systems covering an area of about 900 acres, resulting in about 96,000 feet of terraces being staked off. Much interest is also being shown in the drainage of swamp and overflowed lands. Fourteen examinations have been made for swamp lands, comprising an area of over 400,000 acres; and seventeen examinations have been made for overflowed areas embracing over 37,000 acres.

We have also established two experimental plats for the purpose of making a study on the spacing and depth of tile lines. In connection with the experimental data, we have established two gaging stations on Piedmont streams for overflowed areas embracing over 37,000 acres.

Furthermore, we have conducted a number of tile drainage demonstrations and drainage exhibits, which seems to be a good method for reaching the individuals.

This work in the State is a large one, and we feel that any force with an aim for drainage accomplishments will do good. We therefore sincerely hope that the Drainage Division and the North Carolina Drainage Association can work together for a common cause.

Mr. N. L. Cranford of Winston-Salem, during 1915 printed in a pamphlet entitled "Drainage Pays" a series of letters from progressive farmers of Piedmont North Carolina, telling of the splendid results obtained from draining bottom lands. It is believed that these will be of value to those who are interested in the reclamation of the overflowed lands, and they are incorporated in this report as

RESULTS OF DRAINAGE IN PIEDMONT NORTH CAROLINA

From Cabarrus County:

CONCORD, N. C., R. F. D. No. 2, October 14, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Will answer your letter with pleasure. We had our swamp lands drained last December, and the bad weather last winter prevented a great deal of land from being plowed, but we have some as fine corn as you have ever seen grow, and we have a fine crop of clean hay. We are gathering corn and hay this year where last year we raised frogs and mosquitoes. The people are highly pleased. It cost about \$20 per acre to drain our lands. If you will come down, would be glad to take you over our ditch.

We made some mistake in shaping our ditch. It was cut 24 feet at the top, 14 feet at the bottom, 10 feet deep. That gives you too straight a bank. If we had only cut bottom of ditch 10 feet our banks would have stood up better. If there is any information that I can give you, I would be glad to do so.

O. O. OVERCASH.

CONCORD, N. C., R. F. D. No. 1, October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Yours to hand and contents noted. Would say in reply that it cost \$18 per acre, and that it will pay you to dredge it if the stream is not too large. But to tell you anything about yours I would have to see the stream myself. It will pay you to have some one to look over your district that has had some experience in the business. I went to see several creeks that had been dredged before I would dredge. There are a good many things to take into consideration. The most important thing is the Board of Viewers. They should be men that know what they are doing, men that have had some experience in the matter, to give justice to all concerned.

I have some very fine corn, but one big overflow did some damage.

You will always find some kickers, no matter what you do.

If there is anything that I can do for you let me know, and if it is possible I will do it.

Yours as ever,

CHAS. A. FISHER.

CONCORD, N. C., R. F. D. 2, September 23, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In reply to yours of 17th inst., will say my bottom land on Coddle Creek was dredged last winter, the work was finished March 12th. I was taxed on 65 acres of class A and 32 acres class B. There is just about 300 rods through my land and my dredge bill was \$1,923. I afterwards spent \$125 in three-foot ditches. This land for the last thirty years has been almost worthless, used for pasture and swamp hay. I succeeded in getting 30 acres planted in corn, which was no easy job, and through the month of July people came from a distance to see the corn. It was a pretty picture and was generally estimated at from 60 to 100 bushels per acre. About the 10th of August we had a freshet that put the water three feet deep all over the land, and then four weeks of wet weather which damaged the corn at least one-third. Now a lot of this corn was not planted until June 15, and I think I can safely expect 1,200 bushels of corn. I have also made 105 loads of hay on what I did not work. This hay would have been worthless without the ditch. Our ditch, which is 14 feet at bottom, 24 feet at top, and 10 feet deep, has taken care of all rains nicely, until the freshet of August 10th. I will also tell you I was at the start not in favor of dredging, but to please the majority of landowners I agreed to go into it, and now my opinion is that if the ditch lasts ten years dredging is cheap at any cost. I will also tell you that within the last sixteen years I have seen the water, four times, five feet deep and 1,000 feet wide over this land. Had I the work to do over I would prefer a ditch 10 feet at bottom, 30 feet at top, and 10 feet deep. Forty and fifty years ago I made fine corn on this same land, but for thirty years I have not had a plow in it.

Wishing you success if you dredge.

Yours respectfully,

J. A. RANKIN.

CONCORD, N. C., October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Replying to your favor of the 7th inst., will say I am in one drainage district and think I will be very much benefited. This is my first

year and it has been a severe test, as our stream has had more water to contend with than for a number of years, and yet I have some fine corn on and that is often too wet to mow. It made fine grass, but it was so low and wet that I got very little good hay. Then our ditch was cut too late to get our lands in condition in time for a good crop, and some of it was poorly prepared; but most every one is well pleased, and it has opened up a fine body of corn land, and I believe our district will raise 10,000 bushels more corn than the same land would have raised without the drainage. There are 3,300 acres in this district, but some of it is uncleared and a good deal was not planted this year on account of the work being completed too late to plant. We expect much better results another year.

Wishing you success in your enterprise, I am,

Yours truly,

JOHN P. ALLISON.

CONCORD, N. C., Route 2, October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—I will this evening write you in answer to yours of the 7th inst. I like the drainage work fine. If our land had not been drained we would not have gotten anything off the bottom this year. We have fine corn and hay.

About the cost—that will depend on how wide your bottoms are and how long your ditch will be. Our ditch is five miles long, and our A grade was \$23. I think draining is the only way to work the bottoms. We are all pleased with our drainage. It has been drained ten months.

Yours very respectfully,

G. M. TAGGART.

From Mecklenburg County:

CHARLOTTE, N. C., October 15, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—As requested as to what I thought of drainage work, beg to say that in the past four years I have spent about \$5,000 for drainage and I consider the money well spent, and if I had the work to do over again I would do the same as I did.

The creeks I had dredged were made about 22 feet wide and about 10 feet deep, and I wouldn't recommend any smaller size.

If there is any other information you would like to have and if I can give the information, I will gladly do so.

Yours very truly,

GEO. P. WADSWORTH.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In reply to your request relative to our experience with drainage work, we will say that the writer has had a great deal of experience and is really in a position to testify accurately.

I represent a plantation that was recently drained in which there was approximately one hundred acres of bottom land. This land prior to the dredging was not worth \$1 per acre; but since it was dredged, the land today could not be bought for \$200 per acre. This is a plain fact, with no exaggeration whatever. The entire draining cost us approximately \$1,300, and we

are sure that we have a benefit of not less than \$15,000. I could state this for several others, but being personally interested in this particular place, I do not hesitate to give this as my experience.

If you are contemplating any drainage work, I can say that if your experience is as satisfactory as mine has been, you will never regret having the work done.

Trusting that this information will be of some service and with kindest regards, I am,

Yours truly,

E. R. SMITH.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In response to your inquiry as to my opinion of drainage and my opportunity for forming my opinion, will say that my first impression before I knew the benefits was adverse, because I felt that it was an extra and unnecessary tax levied upon those living along the area. At the time I was living within a few hundred yards of the creek proposed to be drained. The mosquito was a regular unwelcomed guest at my home. The promoters of this drainage area assured me that if the creek was dredged properly I would not be subjected to near so much torture, and consequently would not so likely have malaria in my home. I was in the minority, so the ditch was dug. I am glad to testify that there is not nearly so much malaria in our community as was found prior to the dredging of our creek.

Since that time, in order to protect my financial interests in a transaction, it became necessary for me to become one of the owners of a 400-acre farm which is situated on McDowell Creek in the northern section of our county. There is in first and second bottoms on this creek approximately 75 acres, which at the time of our purchase was densely covered with briars and willows. After considering how to make use of the bottom until the land-owners along the creek would consider dredging the creek, we decided to clear away all the growth for the purpose of making pasture. In the dry season of August I put the laborers to work, and in many places they found the ground so wet and miry that it was impossible to work.

The quality of this soil was such that it set us to work to get the creek laid out as a drainage area. After this was accomplished and necessary financial arrangements were made the ditch was dug. The boat had made sufficient progress by May, 1914, to justify us in planting what we had cleared. Then in August, 1914, I had the remainder cleared, and this year we have the whole area in corn. Many farmers have visited our corn fields this year, and 4,000 bushels is the lowest estimate placed by any of them on the 75 acres for this year.

From the standpoint of health, drainage has proved to me that it is a success, but even more so as an investment.

Yours very truly,

S. W. DANDRIDGE.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—At your request I am pleased to express to you my views and opinion as to the drainage of our farm lands in this county and Rowan (where it has been done). I was one of a jury of three to go over the entire

system of work done here in order to classify same, and think I know whereof I speak. Had I any land in Mecklenburg and could get it, I most assuredly would not do without it, for I have seen the "desert blossom like a rose."

My farm in southwest Rowan contains something over 400 acres, with Sill's Creek (before full of sand) running through at least 65 acres. I was enabled to mow about one-half of it; the balance was to pasture, and wet at that. Our people put their heads together last winter, and this spring the big ditch was completed. My man began to plow during the winter for corn, and was enabled to get in about one-half of the land. I wish you, or any farmer, could see my crop of corn, having had only two workings. My man estimates it at from 800 to 1,000 bushels. When I get the balance I intend for corn, I feel pretty well assured I can begin to pay for my drainage work with what I do not consume on the place. This land only gave me hay before this ditch was dug. I think I am safe in saying it has added at least 50 per cent to my farm, and I am sure the 65 acres would bring \$100 per acre. Now I failed to mention this fact in connection—"Health" (worth them all). My man said to me before I bought the place that it was "chilly," and so it was, but I am happy to state I feel they are things of the past. Your people will never regret it if they ever have it done.

Wishing you success, I am,

Very respectfully,

GEO. M. PHIFER.

From Iredell County:

STATESVILLE, N. C., October 9, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR MR. CRANFORD:—I have your letter about the drainage work here. I have had no work done myself, but I am quite familiar with the work that has been done, and it was done, some of it, at my instance. The first work done in this section was Clark's Creek in Catawba County. Then Third and Fourth creeks in Iredell county were dredged. Later a creek in Caldwell was dredged. Since that time one or two streams in Rowan and two or more in Cabarrus also have been drained. Very fine corn is now growing on the bottom lands of all these streams.

Of course these bottoms overflow sometimes, but that is the case on all streams. It was not the intention of the farmers here, and the engineers did not promise a canal that would carry the water at all times. The fact that farmers have been able to grow large crops of corn and grass on these bottoms is convincing evidence of the value of the work.

One farmer on Third Creek, two years ago, made about 4,500 bushels of corn where he had been making none, or next to none. Another made 1,700 bushels.

I think it pays well to dredge these streams and reclaim the low land. It is expensive to try to grow corn on upland all the time. The draft on the land is too great. It is almost impossible to keep up the fertility of the land. When corn can be grown on bottom land, and the upland used for grain and clovers, it is not a hard proposition to keep up the land.

I hope you can get the creek dredged. I take it you mean Muddy Creek. It needs it very much. I hope this information will be satisfactory.

Yours truly,

E. S. MILLSAPS,

District Agent.

From Gaston County:

GASTONIA, N. C., October 13, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Yours to hand a few days ago, and noted. There have been two creeks, Long Creek and Crowder's Creek, in Gaston County, dredged in the last few years. I am very familiar with the lands on both these streams and am secretary and treasurer of the commission which dredged Long Creek. These lands were almost worthless before they were drained; now they are in cultivation and some of the farmers claim to be making from 50 to 100 bushels of corn per acre. On each of these streams we made an assessment of \$15 per acre, to be paid in installments of \$5 per acre for three years. This was for the lowest, wet lands, and the assessments were less where the land was not so low and swampy. The health of the community has also been greatly improved by getting clear of the chills and fever. We still have our dredging machinery, and the same is for sale cheap. If you get your district organized we would like to take this matter up with you. Please let me hear from you later.

Yours truly,

E. L. WILSON,
Secretary-Treasurer.

Gaston County D. Com., No. 1.

STANLEY, N. C., October 13, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Your letter of the 9th received and note that you contemplate dredging. In regard to our ditch, will say that we would not be without it for twice what it cost us. Our land was not worth over \$10 per acre before it was ditched, and now what has been sold since has brought \$100 per acre, and very little has been sold at that price. I have 75 acres on the creek that was not bringing me anything, and now I am getting about 50 bushels of corn per acre on all I have cleaned up. There will be enough corn raised on our creek this year to pay for the entire dredging bill. Our creek has not been out of the banks but three times since it was ditched. By the time we get ours paid for it will have cost us about \$20 per acre, and I believe it is worth \$50 per acre to us.

If you can get some of the interested parties together and will pay my expenses I will be glad to come over and tell them just what our ditch has done for us.

If there is any further information I can give you I will be glad to answer all questions.

Yours very truly,

W. R. RUTLEDGE.

MOUNT HOLLY, N. C., October 15, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—I have your letter of the 7th inst. I should have written you sooner but have been away from home practically all the time. We finished our creek nearly one year ago. We began eighteen months before we finished. The landowners on the upper end of the creek made more than enough corn over and above their expenses to pay their entire dredging bill, where they had been making two or three hundred bushels, and that only occasionally, and a lot of muddy hay. They gathered 1,000 bushels each last year, and I understand it is better this year. My land is on the lower end and I did not get to put it in last year. I expect to gather something like 1,200 bushels

this year, and I didn't get one-half of mine in, but I pastured 40 head of cattle on that not tended. I will say, with the season we had this year and the creek not dredged I would not have made 100 bushels of corn, and I could not have pastured my land half of the time. And where our land was practically worthless before we ditched, you can't buy an acre for less than \$100 now. We are so well pleased that we are contemplating in a few years to run over it again, throw out the stumps, canes, etc. Our dredging cost us approximately \$17 per acre, but we still have the boat. Should we be able to sell it for something like 50 per cent of what it is worth it would reduce our cost to about \$15. We did not contract, and would not if we had it to do over. It is my opinion that if you have something like 100 acres to the mile it is the best investment any community can make. Any further information that I can give you will be glad to do so; and would like for you to come down and look over our creek, for we have one of the most treacherous creeks in the country and one of the longest. We would sell you our outfit cheap also.

Yours very truly,

T. L. WARE.

RESULTS OF FARM DRAINED SWAMP LAND IN EASTERN CAROLINA

The following paper was read by Mr. B. E. Rice, Industrial Agent of the Norfolk Southern Railway at the semiannual convention of the National Association of Railroad Industrial Agents at St. Paul, Minn., in May, 1915. Mr. Rice was a most active supporter of the North Carolina Drainage Association, and intensely interested in not only the reclamation of these swamp lands but their utilization, and it is believed that this paper will be of great interest to the readers of this report.

INTENSIVE FARMING IN THE DRAINAGE BELT OF NORTH CAROLINA

By B. E. RICE

The Coastal Plain regions of Eastern North Carolina represent conditions unknown elsewhere in America. The geological formation of the territory proves that it was formerly a part of the ocean bed, and that earth upheaval and changing conditions placed the area a little above sea level.

By the laws of gravitation the movement of rainfall water from mountain top and the elevated regions is toward the seashore, and thus, during centuries of time, the residual soils and silt from the higher lands to the west have slowly moved eastward and become a deposit over the lower areas along the ocean shore. The results is that the entire Coastal Plain section of Eastern North Carolina represents a surface deposit of soil fertility contributed by thousands of square miles of territory to the westward, the mother soil base extending even to the mountain tops, dividing the Atlantic slope from the Mississippi basin.

LEVEL SOIL

From the Carolina coast line the soil area for an average of fifty miles inland represents an almost absolutely level surface, as indicated by the

location of the sounds and broad rivers which intersect this entire east coast territory at intervals so frequent that they give to the country the appearance of a gigantic spider web.

Prominent among these waterways we mention the Albemarle Sound, the Pamlico Sound, the Neuse River, and the Pamlico River. These represent natural basins or waterways, and lying midway between them may be found a low ridge or watershed which directs the drainage flow toward these outlet basins. To any one familiar only with mountains or upland territory, it would be difficult to appreciate what a fall of only one foot per mile means in the way of drainage possibility to a level country. In Eastern North Carolina the word "uphill" may mean an elevation not exceeding one foot per mile, and yet this slight surface variation creates a drainage possibility that unlocks the great agricultural wealth of over 3,000,000 acres in North Carolina alone.

In this coastal region there exists a queer condition, in the fact that the dividing or watershed areas, the lands with the greatest elevation, represent the richest type of soils and are locally known as "swamp lands." Of a truth it may be said that the swamps of Eastern North Carolina are the hilltops, as such is the veritable fact. The lands lying near to the streams or waterways, and which are of a lower level, are almost invariably the light gray soils and of a sandy-clay type. These do not contain more than the ordinary amount of humus usually found in soils of that type, but as the surface level gradually increases, back from the water line, there is a change in the soil condition from gray to black, and the surface humus and black soil depth increases in proportion to the elevation increase, until at the dividing watershed this black soil accumulation will be found to measure from six to ten feet in depth. This accumulation represents centuries of decaying vegetation, grown on the original silt and deposit soil brought down from higher lands to the west. The humus in this black soil will vary from 40 to 90 per cent, the greater portion of the areas representing from 50 to 75 per cent of vegetable matter in various stages of decay.

SWAMP LANDS

With reference to the statement that the so-called swamp lands of Eastern North Carolina are the hilltops, and in refutation of the local use of the word "swamp," I would say that the dictionary definition of the word "swamp" is "a low spongy land," and the Bible teaches that the Creator made all things for the best, inference being that man could not improve on Nature.

Conditions in Eastern North Carolina disprove both the dictionary and the Bible in theory. Not but what both are right in the true facts, but man is wrong in the theory of application. On the watershed areas of Eastern North Carolina today man is actually improving on Nature by the installation of additional drainage, converting the "unfit-for-tillage" lands into a rich farming district. These lands are of a swampy condition, but do not represent the actual swamp of dictionary distinction.

Only within recent years has the State of North Carolina had practical or effective drainage laws, hence the rich soil areas of the Coastal Plain section have long remained undiscovered and unappreciated. The law of supply and demand, the rush of farm land settlement in the United States, now brings this area into prominence. This is due to the great possibilities for

ready drainage and easy development. The quickness with which these newly drained lands come into production and the low cost of development and operating, averaged against the valuable crop yield, show ready cause for these lands coming into good demand.

As a rule the greater portion of the level or drainage areas are covered with thick timber. Frequently large areas have been burned over by destructive forest fires, the greater portion of the timber growth being eliminated and easy development conditions presented. With the installation of main canal drainage in these open land areas, development becomes only a question of clearing the land of reeds and brush and the removal of burned logs and stumps sufficient for rough plowing. This clearing usually requires a per acre cost ranging from \$4 to \$10, after which the land can be rough broken with a grubbing plow at a cost of from \$2 to \$4 per acre. The land becomes immediately available for planting, corn usually being the best and most successful first crop.

DEVELOPMENT WONDER

The development wonder of the new lands, however, is the subjugation of the more thickly timbered portions of the black soil areas. In the hardwood districts of the Northern and Western States the converting of timber lands into cultivated fields requires several years, between the axe and the plow, time sufficient for the stumps and logs to rot away. In contrast we find that the black soil timber lands of the Carolina drainage districts are covered almost wholly with gum and other softwood varieties, quick to decay, and nearly all of surface root formation.

After the timber of milling grade has been removed, contractors, at an average cost of 88 cents per acre, will cut down all the remaining trees of every size and kind. Frequently as much as a thousand acres are cut down for a single development operation. About the first of May the entire area is set on fire and thoroughly burned over, the thicker and more dense the standing timber supply, the greater the amount of fuel, and consequently the hotter and more intense the fire. This fire also creates a rich ash deposit, thereby making an ideal surface condition for crop growing.

After this cut-down timber land has been thoroughly swept by fire there is no more labor or expenditure in the way of land clearing or development in the making ready for planting. Not a stump, stick, or log is removed, not a cent spent for labor of any kind on the entire proposition. The land is ready for planting in first-crop corn. A gang of men, with sharpened sticks as their only implements, go over all the newly burned area, make holes promiscuously among the stumps and logs, drop the seed corn in these holes, and cover with the boot.

SHOTGUN PLANTING

When the corn begins to come up it looks as though it had in reality been planted with a shotgun. About two kernels are planted to the hole, and by not being in rows, but scattered here and there, nearly double the number of stalks can be grown upon an acre than if the land was handled by cultivation methods. Strange as the story may seem, this crude stone-age method of planting is the only labor of any kind that is expended on the crop until it is time to gather the corn in the fall. There is no cultivation of any kind, either by hand, hoe, or team work. The method is known as growing "stuck corn."

The crop is usually gathered by contract at 8 cents per bushel, from standing corn to crib. The ears are taken from the stalk in the condition known as "slip-shuck," and are cribbed with a considerable portion of the husk still remaining on the ear.

When we stop to consider that an acre of land that is in a thick timber and jungle condition one year will present to the development or owning company a full crop of corn the following year, and at a growing cost of about 10 cents per bushel for production, then the real meaning of the word wonder becomes apparent. The wonder becomes more emphatic, however, when we realize that the average selling price of this corn is at least 90 cents at the farm.

Stuck corn can be planted at a cost of from \$1 to \$2 per acre, and the crop yield will average from 40 bushels to 60 bushels per acre. There are several instances where measured acres have yielded from 75 to 100 bushels, and other solid tracts of 200 to 300 acres of stuck corn, combining all varying conditions, have yielded an average crop exceeding 50 bushels per acre.

THE RESULTS

In verification of results obtained from land development by stuck corn methods, we cite one instance where a 90-acre timber tract was fenced, ditched, cut down, burned, planted to corn, the crop gathered and cribbed, all at a total cost of \$2,748. The crop yielded 3,964 bushels of shelled corn, an average of nearly 50 bushels per acre. The net cash returns from the sale amounted to \$3,250, exceeding the entire cost of land development and operating by over \$500. After making this one crop of corn, the owner then sold the land for more than double its original purchase price. One hundred per cent, plus \$500, for a one-year investment.

Western corn growers would be unwilling to concede to North Carolina the honor of wearing the laurels for greatest per acre production in the United States, but facts are already against the West. In 1911, North Carolina had an official record yield of 226 bushels of shelled corn per acre. In 1912 one county in the drainage belt, overlooking Albemarle Sound, made the record of 223 bushels yield per acre. In 1913 one of the North Carolina Corn Club boys made the record of 192 bushels per acre, grown at a cost of only 19 cents per bushel, ranking third in world's record. Another boy's record was 187 bushels per acre, fourth in world record production at minimum cost. On my own farm at Wenona, N. C., we made a yield record of 174 bushels of shelled corn per acre at a production cost of only 12 cents per bushel. All of these quoted records are in the drainage district of Eastern North Carolina, and along the line of the Norfolk Southern Railroad.

While the characteristic location of the black soil in the Coastal Plain region is on the elevated or watershed areas, the lands lying nearer the waterways are usually of the lighter or sandy-loam type. These gray or sandy soils are also found quite extensively a little farther in, bordering the drainage territory. In some instances the gray lands are equally as level of surface as the dark soils, and are as greatly in need of thorough drainage. Wherever this drainage is installed the land proves especially valuable in the production of bright tobacco, yielding a crop that grades high in the market, and affords large yields per acre.

As evidence of these yields, the annual crop record for a part of the tobacco territory, based on a central point and within a radius of thirty miles, show

that the tobacco crop of 1914 for this territory alone yielded over 110,000,000 pounds, sold at an average of 15 cents per pound, a cash return from this limited territory amounting to \$16,500,000.

MANY PRODUCTS

But tobacco is not the only farm product sold from this territory. Within this same radius the cotton crop of last year amounted to over 150,000 bales—75,000,000 pounds, which at 10 cents per pound would amount to \$7,500,000. The cotton-seed products from this district yielded an additional \$1,500,000, making a total cotton crop farm return of \$9,000,000 for the same territory that produced \$16,500,000 worth of tobacco.

And still this is not all. The great Coastal Plain peanut territory overlaps a portion of the tobacco belt to an extent that at least another million dollars' farm crop returns can be credited to this same area. Neither must we forget that quite a portion of this area is in the potato and early trucking belt. Our farm figures must have an additional upward boost of more than \$2,000,000 as actual record returns from trucking.

We must not overlook the live stock and meat produced and sold from this same tobacco territory. Although live stock production is somewhat limited, nevertheless almost every farm sells its quota of hogs and cattle. This is especially true in the peanut producing territory. At low calculation the meat products from the tobacco farms will add a half million to our figures—and just as we begin to realize the astounding total from this little tobacco belt in the drainage district, an old hen joins in the money music with a loud cackle, reminding us that another half million in returns must be reckoned with out of respect to the hen industry.

Putting together our little column of figures, we find that the crop output from the farms in this thirty-mile radius, surrounding one common center, farm sales of tobacco, cotton, truck, peanuts, meat, and poultry products will amount to over \$30,000,000 as actual cash returns received by the farmers in a district not exceeding sixty miles square.

The crop returns as quoted only refer to a small portion of Eastern Carolina drainage. Another county, small area of about 800 square miles, produces more strawberries than any other county in the world. Another county in the drainage belt holds the world's record for the largest output of tube-rose bulbs, one firm alone shipping more than two million bulbs in a single season. All this in territory that but for drainage would be of little value!

PECULIAR CHARACTERISTIC

A peculiar characteristic of the drainage lands of the Carolina Coastal Plain is their adaptability to varied crop production. The drainage farmer is not restricted to one or two staple crops, but he can as successfully grow all the products of the South, and he can outrival the northern farmer in the production of some of his few favorite specialties. We have already captured the national banner for record corn production, both in yield and cost, and other crop record banners are in easy reach.

Our tobacco farmers are all getting rich. Why not? We have records for 1914 showing where twenty acres of tobacco yielded an average of 1,200 pounds per acre, with an entire crop average selling price of 25 cents per pound, an acreage cash value of \$300, not just for one acre, but for a farm average of twenty acres. We can, and do, produce tobacco for \$50 per acre.

Cotton production in the drainage territory will double the State average yield per acre, and North Carolina ranks near the top in cotton growing average.

Peanuts represent another profitable crop, and the producing territory lies wholly in the eastern or drainage portion of the State. The average yield for an acre of peanuts is 50 bushels, weighing 22 pounds per bushel, and 3 cents will represent the average farm selling price per pound. Government statistics quote the annual peanut crop yield for North Carolina as over six million bushels, valued at over four million dollars. Peanuts are easy to grow, are not a heavy drain on the soil, and the light sandy lands bordering along the waterways are readily adapted to growing this crop.

We have referred to growing profitable crops of corn, cotton, tobacco, and peanuts. These only serve as a good heading to the list. The live-stock man, who desires heavy yields of forage crops with which to fill his silo, will find the drainage district of Eastern North Carolina an El Dorado land. Nowhere else can be grown such large yields of cowpeas and soja beans, for either hay or grain. Two crops of this forage can be grown in a single season, and on the same acre; or a crop of Irish potatoes can be grown first, to be followed by a crop of peas or beans, either for hay or seed. A single crop of this pea and bean hay will easily yield two tons per acre, selling at the farm for \$20 or more per ton. In quality this hay will rank with alfalfa, either in feed value or in preference by the animal. Where peas and beans are grown for seed, the crop is exceptionally profitable, selling as high as \$1.50 to \$2 per bushel, and yielding from 40 to 50 bushels per acre.

Western alfalfa growers claim for their crop that it can be grown on rolling or upland only. In Eastern North Carolina we are successfully growing alfalfa only four feet above sea level, six cuttings per season, and with an average total yield of five tons per acre.

A favorite green pasturage crop and one well adapted to the drainage belt is winter oats. This crop may be sown in September, used for pasturage during the winter, and with the coming of spring will make an excellent crop of either hay or grain, and can still be followed with a crop of corn or hay crop of peas or beans.

VARIED CROPS.

Staple farm products and live stock are not the only crops to which the Carolina drainage belt is adapted. Irish and sweet potatoes, cabbage, strawberries, and other like trucking crops do exceptionally well, and the quickness with which these products can be moved to the eastern city markets make trucking an attractive feature in drainage belt farming.

In connection with the great trucking possibilities of Eastern North Carolina, a frequent inquiry is why there have remained such vast areas of undeveloped lands, and why the possibilities of the section are so little known elsewhere. The query is logical, the explanation equally so—inefficient drainage and insufficient population. Only six years ago North Carolina adopted its first drainage law. Without adequate drainage the development of the greater portion of the Coastal Plain country was an impossibility.

Another fact to be borne in mind is that North Carolina had no subsidized railroads, favored with land grants, assuring earnest and profitable railroad organization efforts, to obtain settlers for this land. Furthermore, all the Southern States were so impoverished by the war that they were necessarily

slow in recovering from its effects. At the beginning of the War Between the States North Carolina had a total voting population of only 115,000, yet she contributed from her citizenship 124,000 soldiers to the Confederate Army and 9,000 to the Union Army, a total of nearly 133,000 soldiers from a voting population of only 115,000. With the close of the war over 40,000 of these soldiers were counted among the lost; nearly one-third of her citizenship. No other State, either North or South, had a condition even approaching this record. Many years were required to recover from this great loss of population handicap and to bring the State into its rightful producing power.

As a summary of results and possibilities in the way of intensive farming in the Eastern Carolina drainage belt, I might say that we are as yet only knocking at the doorway of investigation, no one mind having fathomed the measure of varied production possibilities. North Carolina was the only State in the Union able to fill every blank in the census report; the only State with a crop production so varied as to be able to furnish statistics to conform with every inquiry; the State where the apple meets the orange. North Carolina holds the grand prize cup won at the National Apple Show over all competitors, and also holds the gold medal for the best box of home-grown oranges in competition with both Florida and California.

Columbus discovered America over four hundred years ago, but the possibilities of the Old North State are only just being discovered.

MR. PRATT: I regret to say that Dr. Hill, President of the North Carolina College of Agriculture and Mechanic Arts, is unable to be with us today, but we have with us Professor M. E. Sherwin as his representative.

PROFESSOR M. E. SHERWIN, of the College of Agriculture and Mechanic Arts:

Gentlemen of the Convention:—Dr. Pratt has explained why I am here as well as I could do it myself. Before beginning my subject I wish to say that I have neither lecture nor notes. You could search me without finding any, so let us proceed to get down to the subject which I believe is put on the program as "Address."

If Dr. Hill had been able to come he would have made a good talk, one both interesting and instructive. If I had received due notice that I was to come on the program, I should have taken a subject closely related to the others we have had this afternoon. I may say a few words about tile drainage before I close.

Especially, however, I bring to the Association a message of good will from the college. Dr. Hill would have done this, and perhaps, inasmuch as I have charge of the drainage work as one division of the soils work of the college, it may be appropriate that I bring to this Drainage Convention the good will of the college and that I should tell you something of the work that we are doing. We sympathize with you in your troubles; we rejoice with you in your progress; we work with you, perhaps along slightly different lines from yours, but nevertheless we all work for the upbuilding of the lands of North Carolina by means of drainage.

The college and the Department of Agriculture may be said to be first cousins. The latter, in coöperation with the United States Department of Agriculture, maintains on its staff two men who for several years have

devoted their whole time to drainage, working out drainage systems for the farmers, calculating cost, and giving other assistance and advice where it has been needed. It was a member of the college staff who, because of demands made by the farmers for field and engineering assistance and because of the impossibility of absenting himself from college classes, first advocated the maintaining of men in such a capacity. Whether or not this hastened the time of their coming, I am glad to say that the men have done good work. The papers which have just been presented on "Tile Drainage" reflect the quality of the work which these men have done, though most of their work has been of the field and office rather than of the literary order.

In the college we aim to give those students who take the drainage course a knowledge of the benefits and methods of drainage. The benefits they know to some extent when they come to us, but the logical reasons for the benefits they do not know; neither do they know the technique.

The information which we give them is both practical and theoretical. Not only do we stand before them and talk to them as I am talking to you now, but we take them to the field for field practice, and to the office where their field notes are worked into plans; then back to the field to put the plans into operation. We take men with no practical knowledge of drainage and make them proficient in the use of drainage levels and other drainage instruments and implements, so that when they leave college they are ready to do something for the State by means of drainage. We take the men to the ditch and teach them to dig and to grade the ditch so that they may later be able to supervise their own work or demonstrate to others. It is ever our ideal to make these men competent not only to perform the engineering features in an approved manner and to lay the tile carefully in the right manner after the ditches have been dug, but to insure by a thorough course in the principles of soils that no plans will be put in operation which will be in any way unsatisfactory. It is the knowledge making the latter possible which should distinguish our students, on the one hand, from the engineer with knowledge only of the handling of engineering instruments and maps; and on the other hand, from the laborer with knowledge only of how to dig the ditch and lay the tile after the lines have been determined for him. Here is the man that above all others will be able to do the work in the best way possible and know enough to leave undone work which would not be profitable.

There is one statement in the address of Mr. Small that I should like to use as the text for a short sermon to the Convention. That is what he said concerning the lack of confidence among the rank and file of farmers in drainage projects, good roads, etc. I realize, as Mr. Small does and as you men do, that we do not have the entire confidence of the farmers. If we did there would be more present with us today. To gain their confidence we must give them, through this Drainage Association, facts regarding the improvement of their land by means of drainage, and these facts must be given to them in a way that they can be appreciated. If we can show them that these improvements upon which we theorize can be made realities, I believe we will have their confidence.

I hope that this Association before another year will effect such an organization as to aid in bringing the farmers together in this Convention. There will be some resolutions presented to the Association in due time that, if adopted and put into operation will, we hope, interest many practical farmers

in the work of this Association and bring them to active work in its conventions.

It is time now for me to begin the subject of "Tile Drainage," if I am to speak on that subject at all, but I fear to start on such a broad subject without some definite outline to stop me. To illustrate the danger of such a proceeding—one afternoon not many weeks ago when one of my classes was scheduled for a four-hour period in the field, it began raining so that we could not go to the field. There were only the alternatives of lecturing or dismissing the class. I chose the former and lectured to the men for three and a quarter hours straight. You will hardly believe me, but the men retained their interest for that length of time. I wonder how many of you would like to have me start now on that same subject. I shall not do it, but will ask that when the proceedings of this Drainage Convention are printed, you thoroughly study the address, "Tile Drainage," by Mr. Lynde. I consider that a most admirable and timely paper.

I thank you for this opportunity of appearing before you.

MR. N. H. HARRISON, SR.:

Mr. President and Gentlemen of the Convention:—Pardon me for referring to myself a few moments. By way of criticism among people who are opposed to development of our country, I am a great apostle to drainage. They look upon it in a way of reproach, but I recognize it as an honor to myself.

There are two classes of people in the world—one is the talking kind, and the other is the working kind. The talking kind is always waiting for something to turn up—the doing kind are inspired by that zeal that will enable them to turn up something. All big things emanate from little ones. All big undertakings move slowly. Like a great stone let down from the top of the mountain, it makes slow progress at first, but it bounds and rebounds and acquires additional momentum as it rolls until it carries everything before it. At no distant day if our friends do not feel willing to fight for us in our drainage battles, we say to them, "get out of the way, for we are coming and will run right over you."

Dr. Pratt wanted me to make some report in reference to Conaby Creek District. This is located in Washington and Beaufort counties. Mr. Small held a Farmers' Educational Meeting in the courthouse of Plymouth in the month of August, 1908. Mr. J. O. Wright, of the United States Department of Agriculture, was there on that occasion. Dr. Pratt was there, and he told us of his experience in the west and that it was once a dense wilderness like ours, and how they applied their energies and made that country bloom like a rose. He filled us all up with enthusiasm. After he got through he said anyone present who wanted to ask questions was at liberty to do so. I got up and said, "Mr. Wright, my neighbors and myself have owned adjoining lands of the corporations that own this great Dismal Swamp that you have been talking about that is so fertile. There are probably 10,000 acres of land that are practically worthless in this section, perhaps with the exception of the timber that is on it, and most of the timber has been cut off, and I want you to tell us how we can develop that land unless we can get that corporation that owns the large areas of that land to coöperate with us." He said, "You cannot do it unless you can get the Legislature of North Carolina to pass a general drainage law, and then, if you possibly can get together, let there be unanimity among you and you can control this corporation and

make them help you develop that country." Mr. Gaylord, whose name has been erased from the marching of time and enrolled with the catalogue of the dead, prepared a petition and asked me to work out what is well known as the Conaby Creek Drainage District in Washington County and Beaufort County, No. 1. We went through the necessary preliminaries as the law required. The agents and the corporations said it would be better for us to serve notice on the corporations to make them parties. We did this.

The clerk wrote to Dr. Pratt to send us a United States Engineer, and he sent him. The viewers were appointed. They accompanied him. They went over that territory and made a favorable report and their findings were accepted by the clerk of the court. A final hearing was given and proper notice, and on that day not a single citizen—and there were 118 in the district—objected. It was passed, but the companies or corporations reserved the right of appeal. The commissioners were elected as the law authorized in section 442 of 1909. I was one of the commissioners appointed by the clerk of the court. I was elected chairman of that board.

In the jurisdiction of my duty and advertising the district as the law requires, the United States Engineer put me in correspondence with 118 dredge companies of the United States. I got my attorneys to notify them, stating that we had a contract to let. We had the right to reject all bids, and any bid that exceeded the estimated cost of the engineer and viewers was not to be considered. Mr. John Wilkinson put in his bid and put in a bid lower than the estimated cost. The Brett Engineering and Contracting Company also put in a bid, and we rejected all of their bids and advertised again, and at the third letting the Brett Engineering and Contracting Company was the last and lowest bidder, and they were awarded the contract for \$100,000.

The John L. Roper Lumber Company and the Roanoke Railroad Lumber Company enjoined the board from selling the bonds until they could be heard on their appeal. The Brett Engineering and Contracting Company employed Mr. Pruden and Mr. Martin to represent their interest in the courts of North Carolina. They put on the evidence that the expense would be greater than the profits, not considering the reports of the engineers and viewers and the wishes of the citizens to the number of 118 in that district. They claimed that we did not put on any evidence. Mr. Pruden claimed that the findings of that court and the evidence of the 118 owners was all the evidence that they needed before that court. The jury brought in a verdict in favor of the corporations. We appealed to the Supreme Court of North Carolina and the Court threw it out, and it leaves today a burden upon the Conaby Creek Drainage District of about \$5,000. We borrowed about \$2,000 to pay for cutting out the right of way for a distance of 38 miles. We had a meeting, and Mr. Elliott was there, Mr. Eason was there, Mr. George Boyd was there, superintending that work; and they said that if that land was ever drained that was the way it would have to be drained. Mr. Brett said after they were taken out, "Now you will have to reassess the citizens to get the money to help me cut the canal." It was more than we could stand. It was doubling their assessments, and it has been lying in that condition now for two or three years, and still this is called justice here under your Drainage Laws. At our last Convention I was in feeble health, but I wrote a letter to Dr. Pratt right before that Convention. Mr. Rice sent us word that at no distant date they would help us to develop this land. The State of North Carolina loaned us \$2,000 to pay for the preliminary

survey. The banks loaned us \$2,000, and if the corporations will not join us in paying it, our people would be much better off if Dr. Pratt and Mr. Small had not induced us to enter upon a debt of \$5,000, which is now proving a burden.

Now I would say in all good feelings to Mr. Small—and I love and revere his name as much as any man in North Carolina—we hope they are going to join us and help us to develop the country to our benefit and their benefit and the benefit of the railroads and the John L. Roper Lumber Company, so that we can take that body of 35,000 acres of land and clear down to Roper, and help us to make something out of it.

Mr. Wilkinson has not got a foot of land, and the John L. Roper Lumber Company have not any, that is better than ours, and it is just as good as any in the United States. The engineers have told me that they never struck a better piece of land in all of their work. (Darkness prevented further report of this speech.)

WEDNESDAY, DECEMBER 1

(On Board Boat to Swanquarter)

REPORTS OF COMMITTEES

COMMITTEE ON RESOLUTIONS

The people of North Carolina are to be congratulated on the splendid progress made in the drainage of the swamp and overflowed lands of the State through the operation of the North Carolina Drainage Law, which has constantly increased the wealth of the State. Looking back upon the conditions which prevailed seven or eight years ago, we are pleased to see the change of sentiment toward drainage as well as the remarkable appreciation shown toward good roads and other progressive movements of the State. We realize that all these progressive movements, particularly drainage and good roads, are mutually helpful, and that success in one must necessarily increase the efficiency of the other: Therefore, be it

Resolved, That whereas it is universally recognized that efficient drainage of the roadbed is one of the first essentials in the construction of good highways, and the work of this Association is to that extent necessarily identified with highway improvement, that an earnest invitation be extended all highway engineers and road superintendents of the State to attend the next and succeeding meetings of this Association, and the sympathetic aid of the State Highway Commission is requested to this end, and that a copy of this resolution be forwarded to the State Highway Engineer with a request that he lay same before the State Highway Commission.

Resolved, That this Association recognizes the valuable assistance of the coöperation of the Office of Public Roads and Rural Engineering of the United States Department of Agriculture, in the furtherance of the drainage movement and the organization of drainage districts since the enactment of the State Drainage Law. The detail of a representative of the Department for exclusive service in this State has been of exceedingly great value in disseminating information and making preliminary investigations as to the feasibility of drainage in many sections. This Association takes pleasure in acknowledging this obligation and in expressing its thanks to the United

States Department of Agriculture; and requests the Secretary of the Association to forward a copy of this resolution to the Secretary of Agriculture.

Resolved, That the extension of drainage, both in the organization of drainage districts and the drainage of individual farms, demands an increased number of drainage engineers competent to advise and make plans for effective drainage. This Association recognizes the instruction now offered as a part of the curriculum of the North Carolina College of Agriculture and Mechanic Arts in the various phases of drainage, but expresses the opinion that this college course may profitably be extended. This Association, therefore, recommends that the course in drainage at the North Carolina College of Agriculture and Mechanic Arts, which is preëminently the college for the teaching of agriculture, shall be so enlarged as to meet the present and future demands for the drainage of our wet lands; that the authorities of this college are invited to send as a delegate to the Annual Convention of this Association at least one representative of the student-body, pursuing the current course in drainage; that a copy of this resolution be forwarded to the president of the college, and also a copy to the president of the Agricultural Club at the college.

Resolved, That this Association go on record in expressing its appreciation of the work of the North Carolina Geological and Economic Survey, not only in forwarding the drainage and good roads work of the State, but in the development and advertisement of the natural resources of North Carolina.

Resolved, That the North Carolina Drainage Association shall have two Vice-Presidents at large, one to be charged with the interests of tile and farm drainage and the other with the interests of the district drainage of the State and in the Conventions of the North Carolina Drainage Association.

Resolved, That the North Carolina Drainage Association shall have a standing Publicity Committee of one, whose duty it shall be to coöperate with the Secretary of the Association in advertising the work and in bringing the results of drainage to the notice of the public.

Resolved, That this Convention expresses its deep regret at the death of our esteemed former member, Mr. B. E. Rice, Industrial Agent of the Norfolk Southern Railroad, and its appreciation of his faithful work in coöperation with this Association in the development of the State; and the Secretary is herewith requested to extend the condolences of this Association to the bereaved family.

Resolved, That this Association extends thanks to the city of Belhaven and its officials for the hearty welcome and support given the delegates to the Convention; to the Belhaven Board of Trade, the Board of County Commissioners of Beaufort County, to the citizens of Belhaven and Beaufort County for the warm hospitality and the many courtesies extended to our delegates, and to the newspapers of Beaufort County for advertising and reporting the Convention.

Resolved, That the thanks of this Association be extended to the Norfolk Southern Railroad for its courtesy in providing a special train for the convenience of delegates.

Resolved, That we extend to the people of Hyde County our thanks and appreciation for providing the means by which we were enabled to visit the Lake Mattamuskeet Drainage District and partake of their generous hospitality.

The report of the Committee on Resolutions was received and the resolutions were unanimously adopted.

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report as follows:

Place for next meeting.....Greensboro
 For President.....Mr. P. H. Johnson of Pantego
 For Secretary and Treasurer.....Mr. Joseph Hyde Pratt of Chapel Hill
 For First Vice-President, in charge of District Drainage,

Mr. M. W. Thompson of Greensboro
 For First Vice-President, in charge of Tile Drainage,

Professor M. E. Sherwin of West Raleigh

VICE-PRESIDENTS OF NORTH CAROLINA DRAINAGE ASSOCIATION

1915-16

<i>County</i>	<i>Name</i>	<i>Address</i>
Beaufort	J. A. Wilkinson.....	Belhaven, N. C.
Bertie	J. W. Cooper.....	Windsor, N. C.
Bladen	O. L. Clark.....	Clarkton, N. C.
Brunswick	J. Ed Taylor.....	Southport, N. C.
Cabarrus	J. Lee Crowell.....	Concord, N. C.
Caldwell	Dr. A. A. Kent.....	Lenoir, N. C.
Camden	W. G. Ferebee.....	Gregory, N. C.
Catawba	T. L. Hannsucker.....	Conover, N. C.
Carteret	Chas. S. Wallace.....	Morehead City, N. C.
Chowan	W. S. Privott.....	Edenton, N. C.
Cleveland	G. F. Hambright.....	Kings Mountain, N. C.
Columbus	Jos. A. Brown.....	Chadbourn, N. C.
Craven	R. E. Snowden.....	Snowden, N. C.
Cumberland	W. A. Beard.....	Fayetteville (R. F. D.), N. C.
Currituck	R. O. Bagley.....	Moyock, N. C.
Duplin	G. O. B. Parker.....	Chinquapin, N. C.
Edgecombe	Zeno Moore	Whitakers, N. C.
Forsyth	N. L. Cranford.....	Winston-Salem, N. C.
Gaston	J. F. McArver.....	Gastonia, N. C.
Guilford	W. C. Boren.....	Greensboro, N. C.
Halifax	John L. Patterson.....	Roanoke Rapids, N. C.
Harnett	J. C. Clifford.....	Dunn, N. C.
Hertford	R. L. Phelps.....	Ahoskie, N. C.
Hyde	D. H. Carter.....	Fairfield, N. C.
Iredell	Z. V. Turlington.....	Statesville, N. C.
Lenoir	C. W. Hodges.....	Kinston, N. C.
Lincoln	W. A. Graham.....	Lincolnton, N. C.
Mecklenburg	W. D. Alexander.....	Charlotte, N. C.
New Hanover.....	C. R. Van Leuven.....	Wilmington, N. C.
Orange	H. M. Berry.....	Chapel Hill, N. C.
Pasquotank	W. J. Cohoon.....	Elizabeth City, N. C.
Pender	W. A. Brown.....	Rocky Point, N. C.

<i>County</i>	<i>Name</i>	<i>Address</i>
Perquimans	A. R. Winslow.....	Winfall, N. C.
Pitt	J. R. Barnhill.....	Greenville, N. C.
Robeson	D. B. McNeill.....	Lumberton, N. C.
Rowan	P. H. Bernhardt.....	Salisbury, N. C.
Rutherford	W. C. McRorie.....	Rutherfordton, N. C.
Sampson	W. C. Tew.....	Huntley, N. C.
Tyrrell	E. B. Hopkins.....	Columbia, N. C.
Wake	M. E. Sherwin.....	West Raleigh, N. C.
Washington	C. W. Mengel.....	Belhaven, N. C.
Wayne	F. K. Borden, Jr.....	Goldsboro, N. C.
Wilson	J. C. Cowley.....	Wilson, N. C.

The report of the Committee on Nominations and Next Meeting Place was received and the officers were unanimously elected. The Convention also voted to hold the 1916 Convention at Greensboro.

The Committee on Membership and Credentials reported 114 delegates present, representing 19 counties, as follows:

Beaufort	Mecklenburg	Robeson
Bertie	New Hanover	Tyrrell
Currituck	Northampton	Wake
Guilford	Orange	Washington
Hertford	Pasquotank	Wayne
Hyde	Pitt	Wilson
Lenoir		

**Registered Delegates at Belhaven Convention, November 29-30,
and December 1, 1915**

Ambrose, A. W.	Creswell, N. C.
Ambrose, J. M.	Creswell, N. C.
Askew, E. S.	Windsor, N. C.
Bagley, R. O.	Moyock, N. C.
Baker, F. R.	Raleigh, N. C.
Barnhill, J. R.	Route No. 5, Greenville, N. C.
Bateman, W. M.	Plymouth, N. C.
Beckwith, Mrs. K. R.	Greenville, N. C.
Berry, Miss H. M.	Chapel Hill, N. C.
Bonner, B. T.	Aurora, N. C.
Borden, F. K., Jr.	Goldsboro, N. C.
Boschen, W. B.	Terra Ceia, N. C.
Bowen, G. W.	Surry, N. C.
Bowen, W. H.	Belhaven, N. C.
Bowen, W. R.	Route No. 1, Pinetown, N. C.
Bowen, W. W.	Route No. 1, Box 57, Pinetown, N. C.
Brinkly, D. O.	Plymouth, N. C.
Brinkley, P. W.	Plymouth, N. C.
Brinn, Charles	Swanquarter, N. C.
Brinson, W. C.	Belhaven, N. C.
Bullock, J. D.	Leechville, N. C.
Bullock, W. J.	Belhaven, N. C.
Bunn, A.	Swanquarter, N. C.
Burrus, J. C.	Fairfield, N. C.
Carter, D. H.	Fairfield, N. C.
Chappel, M. E.	Swanquarter, N. C.
Clark, J. P.	Pantego, N. C.
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1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
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6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
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25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, ... pp., ... pl., ... maps. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, ... pp. *Postage .. cents. In press.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

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3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica. Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analysis of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

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30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

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36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

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38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage ¼ cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, . . pp. *In press.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. *In press.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 75 cents. Cloth-bound copy \$1 extra.*

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Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV.—The Birds of North Carolina—*In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

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Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

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Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

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Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp.
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Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, pp. *Postage .. cents.*

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 46

THE VEGETATION OF SHACKLEFORD BANK

BY

I. F. LEWIS



RALEIGH
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1917

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1917.

To His Excellency, HONORABLE T. W. BICKETT,

Governor of North Carolina.

SIR: I have the honor to submit herewith for publication as Economic Paper No. 46 a report on "The Vegetation of Shackleford Bank", by Mr. I. F. Lewis.

Respectfully,

JOSEPH HYDE PRATT,

State Geologist.

PREFACE

It has been the policy of the North Carolina Geological and Economic Survey to publish, as opportunity offered and printing funds were available, a series of reports relating to the natural history of the State.

In connection with his work at the United States Fisheries Biological Station at Beaufort, North Carolina, Mr. I. F. Lewis has made a study of the vegetation of Shackleford Banks, and it is believed that the results of this investigation will be of value not only in connection with the conservation of land areas along the coast, but will add much to the other botanical studies of the State.

In this as well as in numerous other investigations, we have had the coöperation of the United States Bureau of Fisheries.

It is expected that this report will lead to other investigations which will add more and more to the botanical history of the State.

JOSEPH HYDE PRATT,

State Geologist.

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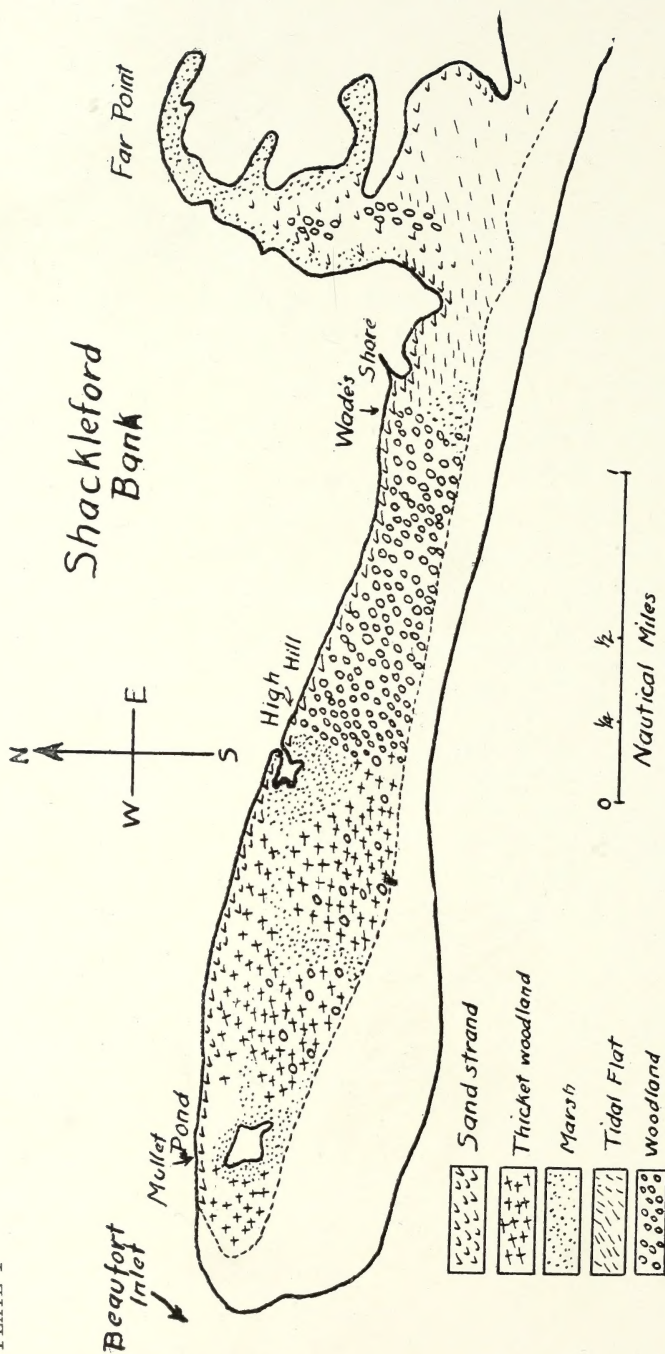
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PLATE I



Detailed Sketch of Shackleford Bank

THE VEGETATION OF SHACKLEFORD BANK

BY I. F. LEWIS.

INTRODUCTION

Shackleford Bank is the strip of land extending from Cape Lookout on the east to Beaufort Inlet on the west. It is about eight miles long and, on an average, half a mile broad. On the south it is bounded by the Atlantic Ocean, on the north by Bogue Sound. Together with Core Bank, with which it is continuous, it forms a long link in the chain of sand reefs bordering the southeastern coast of the United States.

GEOLOGY

Evidence has recently been brought forward by Cobb¹ to show that this long sand reef is essentially a part of the mainland, and that the adjoining sound may be regarded as the estuary of a river which was formerly "a southern tributary of the large river made up of the Pamlico and the Neuse."

SOILS

The soils of Shackleford may be classified under three heads: (a) A fine white marine sand, with little or no humus, is found on the outer beach, the dunes, and in places bordering the sound. (b) A gray sandy loam in the elevated central portion of the Bank. The quantity of humus in the soil varies. In places it is slight in amount, but usually it is present in sufficient quantities to form a good garden soil, capable of supporting a luxuriant vegetation. (c) In the marshes on the sound side of the bank a black mud, 1 to 2 feet deep, is found overlying a sandy substratum.

The soil water is usually 18 inches or less below the surface, and, with the exception noted below, uniformly fresh. Even where the tides cover the marshes, and water standing on the surface is salt, with a specific gravity of 1.023, the soil water is fresh. In this case the ground water probably comes up from below through the sand, the soil being too impervious to allow the surface salt water to percolate through to the fresh water below. Only in the *Spartina-Salicornia* marshes, which are constantly wet with salt water, is the ground water not fresh. Wherever plants other than *Spartina glabra (stricta)*, *Salicornia* spp. or *Borrchia frutescens* grow, the ground water is fresh.

¹Notes on the Geology of Core Bank, N. C.: Journal of the Elisha Mitchell Scientific Society, Vol. 23, No. 1. 1907.

PHYSIOGRAPHY

The elevation of Shackleford varies from sea-level in the marshes to 20-25 feet in the higher ground of the interior. Toward Cape Lookout Light are some shifting dunes perhaps 35 or 40 feet high.

The physiographic conditions on Shackleford are causing rapid changes in the vegetation of the Bank, which will be referred to later. At present it is sufficient to state that the sand of the beach is advancing on the forest at a comparatively rapid rate, destroying the vegetation in its path.

CLIMATE

The climate of Shackleford is very similar to that of Hatteras, described by Kearney.¹ From data furnished by the United States Weather Bureau for Beaufort (2 miles from Shackleford) and Hatteras, the following points of difference are taken:

The annual mean temperature of Beaufort for the last six years is 63.6° F. (17.5° C.), while that for Hatteras for the same period is 62.3° F. (16.8° C.). The maximum summer temperature of Beaufort is slightly higher (about 3° F.) than that of Hatteras, while the minimum winter temperature is slightly lower. There are practically no days at either place when the temperature does not rise as high as 43° F. (6° C.).

The latest killing frost in spring, and the earliest in autumn, occur at about the same time in both places (February 25 and December 13).

The amount of sunshine during the year is less at Beaufort than at Hatteras. At Beaufort the average number of rainy days during the year is 128, clear days 117, as against 118 and 204 for Hatteras. The intensity of light is greatly increased at both places by reflection from the water and the white sand, so that the actual amount of light available for the use of plants is greater than at an inland station with the same number of sunshiny days.

No data are available for determining the atmospheric humidity. The prevailing wind during the growing season is from the southwest, and is laden with moisture from the Gulf Stream, so that the average humidity is probably not less than at Hatteras, where it is notably high.

The annual rainfall is even greater at Beaufort than at Hatteras. During the years 1896-97-98 and 1906-07-08 (the only years for which data on this point are available for both stations) the average annual precipitation at Beaufort was 58.59 inches, at Hatteras 53.12 inches. However, the estimated mean annual precipitation is greater for Hat-

¹Kearney: The Plant Covering of Ocracoke Island; Contributions from the U. S. Nat. Herb., Vol. 5, No. 5. 1900.



A. Portion of the outer beach, showing a small dune built up by *Uniola paniculata*.
Around it are remnants of a destroyed forest



B. The stable barrier dune of the outer beach on Bogue Bank, formed by *Uniola paniculata*. (Photograph by R. E. Coker)

terras than for Beaufort (Hatteras 60.85 inches, Beaufort 52.55 inches).¹ These figures differ somewhat from those quoted by Kearney for Hatteras.

The precipitation is fairly uniform throughout the year. No prolonged period of drought is liable to occur.

The prevailing wind during the growing season is from the southwest. This is the wind which most affects the woody vegetation, so that the trees in exposed positions incline strongly to the northeast, the windward (southwest) side being denuded of branches, while the foliage lies mainly to leeward of the axis. Just the opposite is reported for the trees on Ocracoke.²

NOMENCLATURE

The nomenclature adopted is that of Gray's Manual of Botany, 7th edition, revised by Robinson and Fernald, and in the case of plants not listed in this work, of Small's Southern Flora.

Exact determination of the plants found is of the highest importance in such an account as this. This has been made possible by the kindness of Dr. John K. Small, of the New York Botanical Garden, to whom specimens of practically all the plants listed were sent. I wish to express here my thanks to Dr. Small for his assistance.

PLANT FORMATIONS

The plants occurring on Shackleford Bank may be arranged in the following groups:

I. Sand strand vegetation.

1. Treeless (open):

- a. Inner beach formation: *Croton-Cenchrus* association.
- b. Outer beach formation: *Salsola-Euphorbia* association.
- c. Dune formation: *Uniola paniculata* association.

2. Trees and shrubs (closed):

- a. Thicket formation: *Ilex vomitoria* association.
- b. Thicket woodland formation: *Persea-Callicarpa* association.
- c. Woodland formation: *Quercus virginiana* association.

II. Marsh vegetation.

- 1. Salt marsh formation (closed): *Spartina-Salicornia* association.
- 2. Creek marsh formation (closed): *Juncus-Eleocharis* association.
- 3. Dune marsh formation:
 - a. *Cladium-Kosteletzkya* association.
 - b. *Proserpinaca-Aspidium* association.

¹From Annual Summary, N. C. Section of Climatological Service of the U. S. Weather Bureau, 1908, p. 105.

²Kearney, l. c., pp. 266, 271. I am informed by Mr. W. B. Longest of Beaufort, who has visited Ocracoke daily for some years, that Kearney is in error as to this matter. Mr. Longest states that at Ocracoke, as elsewhere on our coast, the trees are most affected by the summer winds (off the sea), and that the axes of the trees incline toward the North.

c. *Isnardia-Pluchea* association.

d. *Acorus-Salix* association.

4. Tidal flat formation (closed): *Scirpus-Paspalum* association.

I. SAND STRAND VEGETATION.

1. TREELESS (OPEN).

a. INNER BEACH FORMATION.

This formation fringes the sound side of Shackleford except in a few places where the salt marsh extends to the water's edge. The soil is a fine sand, bare of vegetation up to the limits of mean high tide. Above this limit *Spartina patens*, *Cenchrus tribuloides*, and *Croton maritimus*, all perennial species, occur commonly, though not covering the ground completely. *Chenopodium Botrys*, *Physalis viscosa*, and *Salsola Kali* are of common, though not universal, occurrence.

b. OUTER BEACH FORMATION.

The sandy soil is mixed with broken fragments of shells. The soil water stands at a depth of about 12 inches, and is fresh. The outer beach is overrun by the highest winter tides, but is above the mean high-tide line.

The vegetation is sparse and open, the individual plants standing at wide intervals. The loose character of the soil imparts a desert aspect to the vegetation. *Salsola Kali*, *Euphorbia polygonifolia*, and *Amaranthus pumilus* are characteristic of this formation. *Fimbristylis castanea* and *Spartina juncea* (*patens*) occur occasionally.

c. DUNE FORMATION.

The sand accumulated on the dunes is wind-blown and of fine texture. The soil water is fresh and stands at a depth of 18-24 inches.

The dunes are covered with *Uniola paniculata*, whose flowering stalks, sent up in abundance, are very striking. This species appears to set seed rarely in this locality. Besides the *Uniola*, *Physalis viscosa*, *Croton punctatus*, *Solidago sempervirens*, and *Oenothera humifusa* are present. This formation reaches its best development on the neighboring Bogue Bank. (See Plates II A and B and Plate III A.)

2. TREES AND SHRUBS.

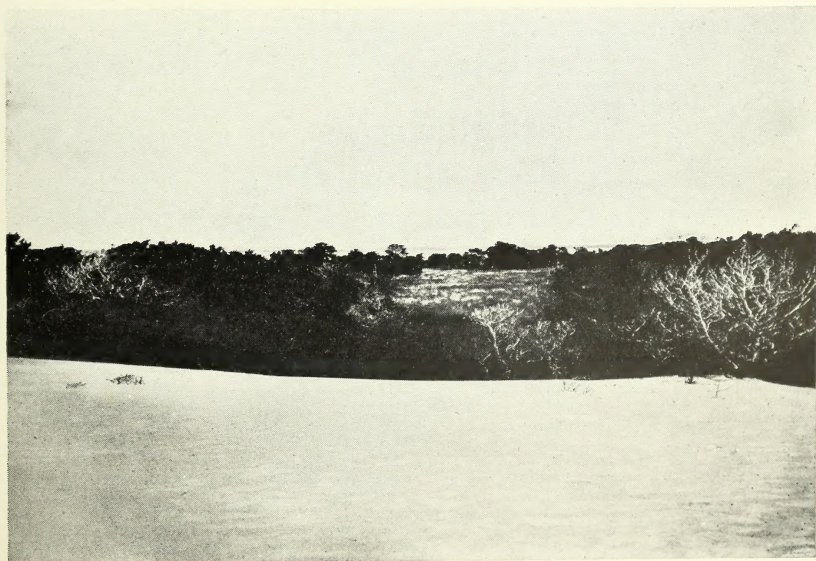
a. THICKET FORMATION.

The soil is sandy, with a slight admixture of humus. Owing to its being completely shaded, it dries out much less readily than the open sandy soil of the preceding formations.

Ilex vomitoria, from a few inches to 3 feet high, covers the ground so closely that one can with difficulty make his way through the thickets. Where a break occurs in the vegetation, *Ilex opaca*, *Juniperus virginiana*, *Smilax Bona-nox*, *Myrica carolinensis*, and other species occur.



A. Face view of the barrier dune on Bogue Bank



B. View of thicket woodland and marsh, taken from the sand wall

b. THICKET WOODLAND FORMATION.

The soil here is a light sandy loam. The vegetation is very dense and consists of a large number of species of trees, shrubs, herbs, and woody vines. The trees commonly occurring are *Persea pubescens*, *Quercus nigra*, *Osmanthus americanus*, *Pinus taeda*, and *Juniperus virginiana*. Of shrubs the most striking are *Ilex vomitoria*, *Myrica cerifera*, *Callicarpa americana*, *Ilex glabra*, and *Sabal glabra*. Characteristic herbs are *Asplenium platyneuron*, *Anychistrum Baldwinii*, *Lechea villosa*, *Hieracium Gronovii*, *Elephantopus nudatus*, *Acalypha gracilens*, *Ascyrum hypericoides*, *Galactia volubilis*, *Desmodium paniculatum*, and species of *Panicum*. Woody vines are very conspicuous. *Berchemia scandens*, *Smilax Bona-nox*, *S. laurifolia*, *Vitis rotundifolia*, and *Psedera* (*Parthenocissus*) *quinquefolia* are most abundant. (See Plate III B and Plate IV A and B.)

c. WOODLAND FORMATION.

On all the higher parts of the island except the dunes, the soil is a deep light sandy loam. On this trees reach a considerable size. The vegetation is much less dense than that of the previously described thicket woodland. Common trees are *Quercus virginiana*, *Carpinus caroliniana*, *Ilex opaca*, *Morus rubra*, and *Quercus phellos* (*laurifolia*). *Ilex vomitoria* and *Zanthoxylum Clava-Herculis* occur commonly as well developed shrubs. The characteristic herbs are *Stipa avenacea*, *Uniola laxa*, *Jatropha stimulosa*, and *Eustachys petraea*. Woody vines, while of common occurrence, are less conspicuous than in the thicket woodland formation. (See Plate V A.)

II. MARSH VEGETATION.

1. SALT MARSH FORMATION.

This formation occurs commonly along the border of the sound. The soil is a blackish mud about 2 feet deep, very impenetrable to surface water. The surface is usually covered with salt water at high tide, yet the soil water, about 12 inches below the surface, may remain perfectly fresh.

The only plants occurring always in this formation are *Spartina glabra* (*stricta*), *Salicornia ambigua*, and occasionally *Borrichia frutescens*. At one point opposite Cape Lookout *Salicornia mucronata* (*Bigelovii*) replaces the elsewhere universal *S. ambigua*. On the next Bank to the north, Ocracoke Island, Kearney¹ reports, in a similar formation, *Salicornia europaea* (*herbacea*) associated with *Spartina stricta* (*glabra*). (See Plate V B.)

¹Kearney, l. c.

2. CREEK MARSH FORMATION.

The conditions of soil and soil water are the same as in the preceding formation. The creek-marsh formation is not, however, covered at mean high tide.

The characteristic plants of this formation are *Juncus Roemerianus*, *Scutellaria palustris*, and *Eleocharis albida*. Abundant are *Scirpus americanus*, *Gerardia maritima*, *Fimbristylis castanea*. (See Plate VI A and B.)

3. DUNE MARSH FORMATION.

The soil is dark as in the salt marsh formation, but is not reached even by winter high tides and the surface water is therefore fresh.

a. Where the drainage is good, the surface water running into small creeks which make their way to the sound, occurs a rich plant covering characteristic of which are *Cladium jamaicense*, *Kosteletzkya virginica*; abundant are *Boehmeria cylindrica*, *Cyperus strigosus*, *Ipomoea sagittata*, *Lippia nodiflora*, *Bacopa Monniera*, (*Monniera Monniera*), *Ammania Koehnii*, *Dichromena colorata*.

b. Where the marsh is inclosed on all sides by neighboring high ground, the drainage is very poor. As already mentioned, the black soil is very impenetrable, and the surface water stands almost indefinitely, becoming dark brown in color. Here *Ludvigia palustris*, *Pluchea foetida*, *P. camphorata*, and *Cyperus haspan* are the characteristic species.

c. In a few places such a poorly drained area seems liable to be covered by the highest winter tides. Here *Proserpinaca pectinata* and *Aspidium Thelypteris* dominate the vegetation.

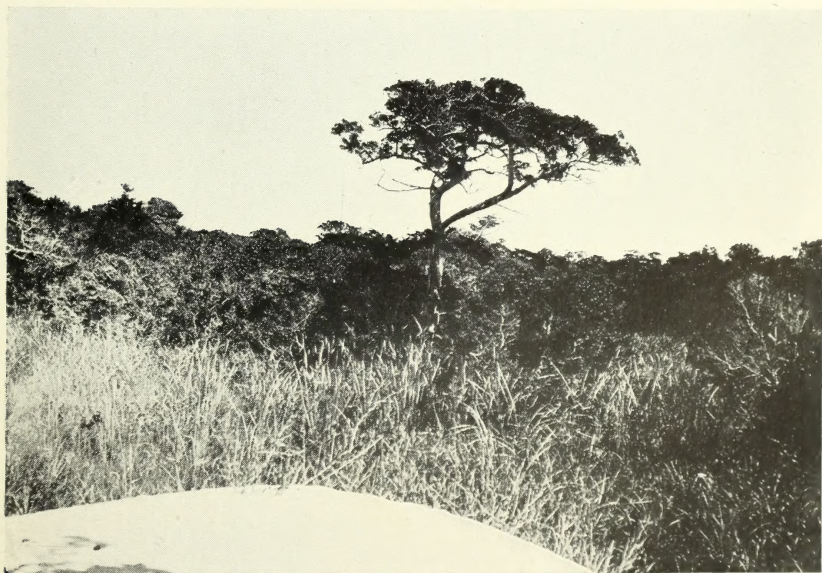
d. In the lee of the highest dunes near the eastern end of the Bank are permanent pools (1-3 feet deep) where *Acorus Calamus* and *Salix* sp. are common. Around these pools occur many of the species noted above. (See Plate VII A and B.)

4. TIDAL FLAT FORMATION.

This occurs wherever an area originally occupied by the dune marsh has become sanded over. The soil is a mixture of the mud of the swamp and the sand which has drifted in. The characteristic association is made up of dwarfed *Scirpus americanus*, 6-8 inches high, and of *Paspalum distichum*. *Fimbristylis castanea* and *Spartina patens* are often met with. All of these are plants at home in the marshes. Besides them, *Euphorbia polygonifolia* and *Cenchrus tribuloides* occur as invaders from the sand strand.



A. Thicket woodland. The trees, *Juniperus virginiana*, and the woody vines, *Berchemia scandens*



B. Dune marsh and thicket woodland

GENERAL ACCOUNT OF SHACKLEFORD VEGETATION

The western end of the island presents a sandy shore both to the sea and to the sound. The sand strand vegetation on the sound side is formed of scattered specimens, only a few species being represented. The most characteristic are *Spartina patens*, *Cenchrus tribuloides*, and *Croton punctatus*. About twenty other species, both annual and perennial, occur occasionally or commonly with these. The majority are either halophytic or pronouncedly xerophytic. The vegetation, like that of the outer beach, is desert-like and unattractive.

Leaving the sound, the strand rises a few feet and passes into the higher ground in the center of the Bank. Here the knolls, of loose sandy texture, are occupied by a thicket vegetation, while in the hollows are swampy areas, with the soil black mud, on which flourishes a luxuriant herbaceous vegetation.

Passing through this area toward the sea one comes on an advancing sand wall, 10 to 20 feet high, which is burying the vegetation at a rapid rate.¹ On the sandy plateau south of this some cedars still stand, the alburnum eaten away by the driving sand, the heart-wood sound. Some of these trees have been uprooted and lie almost completely buried. Others are upright, the topmost branches alone showing above the sand. On those dead cedars which are not covered by the sand are frequently to be found masses of lianas, their leafy crowns replacing those of the dead trees exactly, so that in the distance the trees seem to be living. One such dead *Juniperus* bore five lianas, forming a dense mat where the crown of the tree was, and rooting in the sand. The soil water at this point was 18 inches below the surface and quite fresh. The usual woody vines growing on these outposts of vegetation are *Psedera* (*Parthenocissus*) *quinquefolia*, *Vitis rotundifolia*, *Cissus arborea*, *Rhus radicans*, and *Berchemia scandens*.

Besides these remnants of a once vigorous forest growth, there are present on the sandy plateau between the thickets and the sea only a few scattered specimens of the species usual on the outer beach. The shifting soil is no doubt responsible for the sparseness of living vegetation in this portion of the island. At one point, near the western end, a few small dunes have been built up by the growth of the sea oats (*Uniola*.)² The dunes are low and dome-shaped. Since they are isolated from one another, they do not form a barrier between the outer sand and the inner thickets, as is the case on the neighboring Bogue Bank.³ They are growing and spreading, however, and in time, if left undisturbed, will afford some protection to the vegetation at this end of the Bank.

¹Figs. 4, 6, 11, 12.

²Fig. 1.

³Figs. 2, 3.

The interior of this portion of the island is covered by a very dense vegetation, through which it is difficult to force a passage. The lower ground possesses a black, impervious soil, constantly wet with rain-water, and covered by a dense herbaceous growth. Around these fresh-water swamps the sandy elevations are covered with shrubs and small trees.¹ Woody vines are especially abundant here, growing with a tropical luxuriance which contrasts strangely with the desert-like aspect of the beach formations.²

Between High Hill and Mullet Pond (see map) the sound is bordered by salt marshes, which are overflowed at high tide. The vegetation here is constant in character and appearance. A dense stand of *Spartina glabra*, in which *Salicornia ambigua* is abundant, gives the marshes a uniform grassy appearance. This association is invaded rarely, and then only by *Borrchia frutescens*.

Above the level of ordinary high tides the marsh is given a more varied aspect by the presence of a number of invading species. Of these, *Juncus Roemerianus* is one of the first to appear. This is a large, tall rush, the dark clumps of which dot the marshes here and there. Climbing on the rush is usually to be found a narrow-leaved, slender herb, *Seutera palustris*. Between the hummocks of *Juncus* occurs commonly *Gerardia maritima*, forming purple patches on the level swamp.

East of High Hill the ground is uniformly high, from 10 to 20 feet above sea-level, and the sand strand is quite narrow. In this stretch occurs open woodland, where the vegetation is not so dense as in the thicket woodland farther west. The characteristic trees are *Quercus virginiana*, *Q. phellos*, *Persea pubescens*, *Morus rubra*, and *Ilex opaca*. While some of these trees are of considerable size, none of them attain the dimensions of the same species on the less exposed mainland. Between them *Ilex vomitoria* (yaupon) is the usual shrub, here being beset with numerous short thorn-like branches. Woody vines are conspicuous, the species being identical with those mentioned as occurring occasionally on the sandy plateau bordering the sea beach.³

At about the level of Wade's Shore the open woodland begins to be succeeded by dune marshes. Here the black soil retains the rain-water, which stands at a level of 6-12 inches, and which is brown in color like the "Juniper water" of the Dismal Swamp. These marshes are not of great extent and lie on the seaward side, near the wall of advancing sand.

From this point to Cape Lookout both forest and swamp have disappeared completely save for one or two small groves of live oak, which

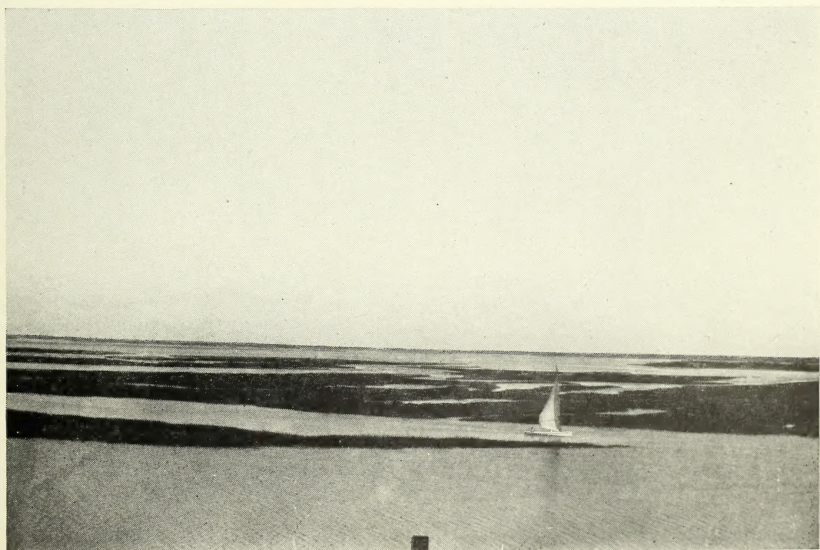
¹Fig. 4.

²Fig. 5.

³Fig. 7.



A. Open woodland, the sand drifting in to the right. *Quercus virginiana* and *Juniperus virginiana*



B. Salt marshes (*Spartina* and *Salicornia*) near the Fisheries Laboratory
(Photo by R. E. Coker)

have been able to resist the advancing sand. Elsewhere this portion of the island is a sandy waste, with little or no vegetation, except that in the lower places may be seen evidences of the swamps that existed here before the advancing sand covered the island from the sea to the sound. In such low flat areas *Scirpus americanus* and *Fimbristylis castanea*, most tolerant of sand and drought of all the marsh species, continue to exist side by side with *Croton punctatus*, *Salsola Kali*, and *Cenchrus tribuloides*, plants at home on the sand strand. *Paspalum distichum* often covers the ground with a weak but uniform turf in such spots, and *Spartina patens* is usually present.

The sand strand also does not extend east of Wade's Shore, but gives way to the flat salt marshes, which border the sound.

Not far from Cape Lookout, about 400 yards from the sea, are dunes some 40 feet high. In the lee of these are fresh pools, fed by seepage from the dunes. *Acorus Calamus* and *Salix sp.* are here present, while around the pools are the shrubs of the thicket formation occurring toward the western end of the island.

THE VEGETATION OF BOGUE BANK

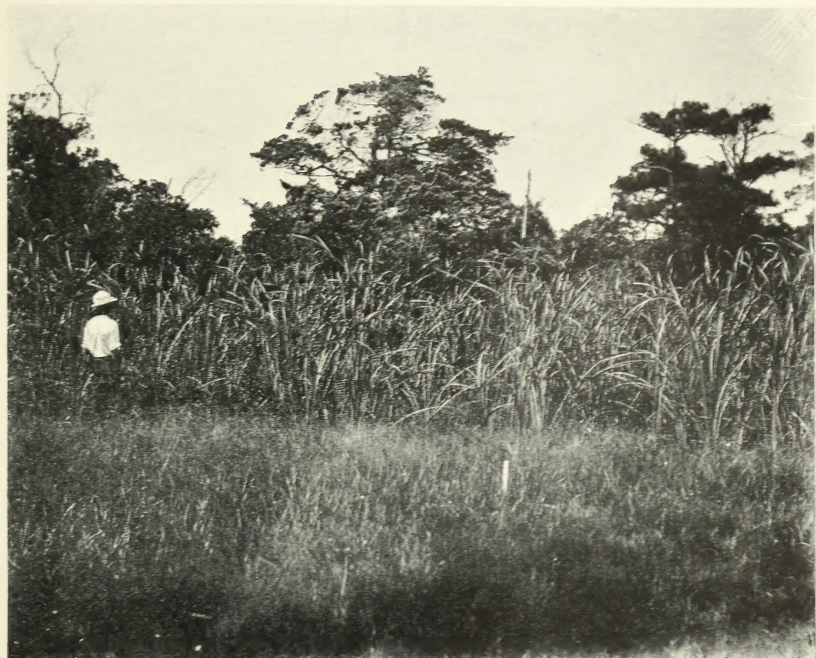
On this bank, which extends west from Beaufort Inlet, physiographic conditions have produced a much more stable configuration than on Shackleford. A line of dunes about 20 feet high, formed and covered by sea-oats (*Uniola*) extends along the bank, and protects the vegetation in its lee from the encroachments of drifting sand. Back of the dunes on the eastern end of the bank for a distance of about five miles the ground is covered by thickets somewhat like those described for Shackleford, though the woody plants are here smaller and more shrubby. *Ilex vomitoria* is the dominant shrub, while *Zanthoxylum Clava-Herculis* and *Juniperus virginiana* are common. In the more open places are the herbs and shrubs characteristic of similar localities on Shackleford.

From about five miles west of the Inlet, the Hoop Pole woods cover the bank, the beach being here quite narrow. The woods are protected by a barrier dune, or sand wall, held in place by *Uniola* and various sand-binding herbs and shrubs, among which a low form of *Ilex vomitoria* is abundant. The Hoop Pole woods themselves are composed mostly of hardwood trees of considerable size, with an admixture of pines and cypresses. The forest here is quite similar to that of the adjacent mainland, and here flourish many plants which cannot endure the severer conditions on Shackleford. Botanically, Bogue Bank from Bogue Inlet to the eastern end of the Hoop Pole woods (about 20 miles) is a continuation of the mainland.

CONSERVATION OF THE VEGETATION

The vegetation of Shackleford Bank is described at some length because of the rapid changes in the physiography of the region now taking place. In the memory of living inhabitants, the Bank was well wooded over its entire extent, the strand separating the forest from the ocean beach being so narrow that it was "possible to sit in a tree and cast a fishing line into the water." Before the Civil War, however, cutting of timber, coupled with forest fires, the grazing of cattle and sheep, and the inroads of gales, had broken the protecting wall of vegetation and allowed the sand from the beach to blow in on the trees. Slowly at first, and then more and more rapidly, the sand was blown in on the vegetation, killing or covering the existing plants. At the present time the forest east of Wade's Shore (see map) has been destroyed, and this portion of the Bank is a sandy waste, with here and there a wind-blown dune sheltering a remnant of the former vegetation. In the western and wider portion of the Bank the progress of the sand has been slower, and perhaps half of the original plant covering remains. Here the work of destruction is going on at a rapid rate. The dry sand, blowing over the wide beach, is carried to the edge of the forest and there falls over a slope of an angle of about 30°. This sloping sand-wall is advancing on the forest at a rate of 4 to 12 feet a year and killing all vegetation in its path. As the beach broadens, the sand will drift in with increasing rapidity, until within a comparatively few years the forest-covering will be obliterated.

The results of this will be twofold. It will probably lead to the abandonment of Shackleford Bank as a permanent place of residence, because without the protection afforded by the vegetation, the winter storms will sweep over the land with such force as to make residence unsafe. In the second place, the sand will continue to drift north with increasing rapidity, and this will have a tendency to fill in the rather narrow sound lying between the bank and the mainland. The hindrance thus caused will be slight, because few boats now pass this way, the channel being tortuous and in places quite shallow. Of more importance will be the effect of the closing of the channel on the fisheries of the region. The enormous number of mullet and other fish now coming through Core Sound to Beaufort Inlet would pretty certainly be diverted to some other inlet farther northeast. Whether this would result in a diminution of the total catch of Pamlico and Core sounds, or whether the loss at one point would be compensated for by a gain at another, cannot be stated. At any rate there would be a serious disturbance to the conditions which now make fishing profitable in this region.



A. Creek marsh and thicket woodland



B. Creek marsh and thicket woodland

For these two practical reasons, then, it seems desirable to protect the existing vegetation of Shackleford from further destruction by drifting sand. A third reason is not less important. From Cape Henry southward along our entire Atlantic Coast similar conditions are met with. What are now forest lands, some quite valuable, are being converted into sandy wastes. The methods which have proved successful in other parts of the world¹ in controlling shifting sands and converting them into forest lands have never been tried in this section to any extent, and it would be of practical and scientific value to conduct experiments along this line on Shackleford Bank. The area to be protected is rather small, so the cost of the experiments would not be very great.

The first step in such reclamation and conservation work would be the production of a barrier dune running along the sea beach similar to that employed on the Kurische Nehrung in Germany and on the southwestern coast of France. The first step in the formation of such a dune would be to form a long ridge of sand, 10-12 feet high, by means of a brush fence. This should consist of two rows of rough stakes or untrimmed branches, driven firmly into the sand and projecting two or more feet above the surface. Such a fence should be set 100 feet from the sea. It would cause the drifting sand to accumulate in a long ridge. When the ridge becomes 10 or 12 feet high, sea oats (*Uniola paniculata*) should be set out after the manner used in other countries in transplanting the sea marram (*Ammophila arenaria*). With some attention a barrier dune would be thus formed similar to that now protecting the Hoop Pole woods on the neighboring Bogue Bank.

After the barrier dune is formed, the region back of it, now a sandy plateau, should be planted in loblolly pine (*Pinus taeda*). The work of reclamation would then be complete, and occasional attention to the barrier dune, with the purpose of repairing accidental breaks due to storms, and preventing blow-outs, would make it permanent.

If the barrier dune is once formed, the work of reclaiming the sandy plateau would be greatly aided by various native plants. Of these the most important are *Spartina juncea*, *Fimbristylis castanea*, *Physalis viscosa*, and *Paspalum distichum*. *Ilex vomitoria*, which seeds very freely, would aid materially in providing a windbreak for the young pines. All the plants mentioned are valuable sand binders, since they have long branching roots or rhizomes which tend to hold the sand. Occasional clumps of *Salsola Kali*, *Cenchrus tribuloides*, *Oenothera humifusa*, *Euphorbia polygonifolia*, and *Solidago sempervirens* would also occur on such a formation, but would be of less importance because their roots strike vertically, rather than horizontally, into the sand.

¹Hitchcock, A. S., Methods used for controlling and reclaiming sand dunes: Bull. 57, Bureau of Plant Industry.

The entire strip involved in such an experiment as that suggested is about three miles long. The cost of building the brush fence cannot be stated with certainty, but would be in the neighborhood of \$500, while planting the sea oats would cost perhaps \$200 more.¹ The ultimate success of the operations would depend very largely on having a competent man to inspect the barrier dune occasionally, say once a month, and repair breaks by means of sand fences.

The prohibitive cost of the reclamation operations suggested by Bond² is estimated from his study of the conditions obtaining at Hatteras. The actual cost of reclamation work on Shackleford would be less than estimated by Bond, for the following reasons: (1) The fence need not be of board, since experience in other localities proves that sand is held sufficiently well by a rough fence or hedge built of untrimmed branches driven into the sand. (2) The sand ridge need not be built up to the height of 30 feet, as recommended by Bond. After the ridge has been raised 6 feet or so from the level of the beach, sea oats should be planted. This species, by its natural growth, would build up the ridge to the desired height.

These two matters are mentioned to show that the estimates of Bond were made without sufficient regard to the local conditions. His recommendations are taken from Hitchcock's paper (l. c.) on Controlling and Reclaiming Sand Dunes, which is based on a study of the methods used in the "Netherlands, Denmark, Germany, and France" (p. 5). These methods, to be successful on our coasts, must be adapted to local conditions, and a study of these conditions must precede successful reclamation work. The results of such a study I have endeavored to include in the present account.

SAND AND SOIL BINDING PLANTS AND THEIR ACTIONS

The character of the soil around Beaufort is such that physiographic agencies act rapidly. The sandy shoals in the sound, and therefore the channels, are constantly being shifted by tidal currents. The sands of the "banks" are extremely unstable, and are continually being moved about by the wind. There are certain natural agencies, however, which tend to check this extensive movement of the soil, and which must be the basis of any permanent fixation of the land. These are the work of sand and soil binding plants, somewhat similar to but not identical with the plants of the same function in other parts of the world.³

A brief account of these plants and their action will be given here.

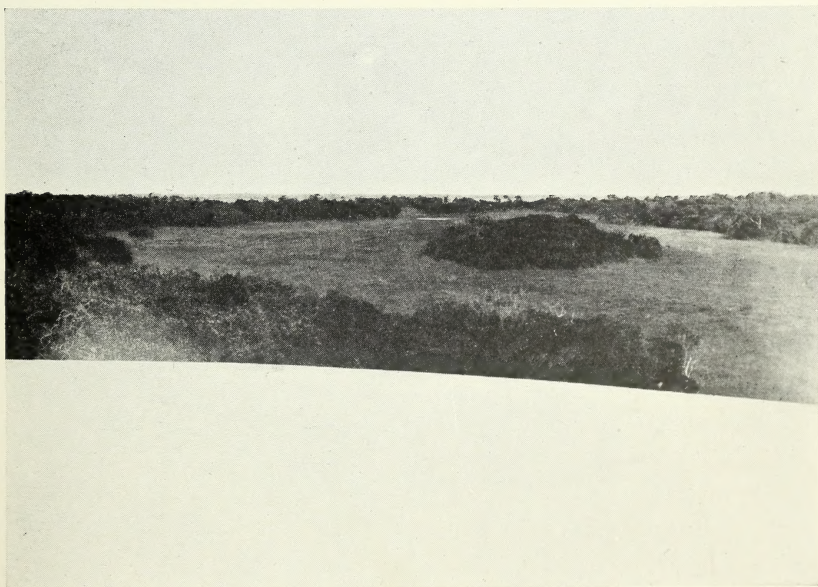
¹These estimates were made in 1909, and must be modified on account of the great increase in the cost of labor.

²Biennial Report of the State Geologist, N. C. Geological and Economic Survey, pp. 42-48, Raleigh, 1908.

³See Hitchcock, l. c.



A. Dune marsh and thicket woodland; on the right the advancing sand wall



B. View from the sand wall across the island to the sound

SOIL-BUILDING PLANTS

The most important are *Spartina glabra*, *Salicornia ambigua*, and *Borrichia frutescens*. These are plants of the salt-marsh, and live only in situations where the soil is flooded at high tide, and where the water is comparatively quiet. They are an important factor in the formation of the numerous flat, marshy islands lying in Bogue Sound and around the mouth of Newport River. At first, sandy flats, quite bare of vegetation, are formed by the currents due to wind and tide. *Spartina* may gain a precarious foothold on the loose sand. It then sends its strong, thick rhizomes here and there, binding the sand on which it grows, adding humus, collecting and holding silt brought down by the rivers. In such situations the grass is stunted and sparse, but by thrusting a spade into the sand one sees that the substratum is closely occupied by the long heavy branching rhizomes long before the conditions are sufficiently favorable for the aerial part of the plant to send up its flowering stalks or even to produce very vigorous foliage. At this stage *Salicornia ambigua* may also gain a foothold and aid in reclaiming the sandy wastes. The building up is accomplished partly by the plants catching and holding the sand and silt brought to them by the currents and partly by the actual addition of dead and rotted plant substance. After these forces have been at work for some time the land may be raised nearly or quite out of reach of high tides, and invaders begin to appear in the highest ground and help build it up further. The common invaders in such situations are *Borrichia frutescens*, *Limonium carolinianum*, *Solidago sempervirens*, *Strophostyles umbellata*, *Iva oraria*, and *Spartina patens*.

All stages of this island-formation can be observed near the Fisheries Laboratory. On Shark Shoal¹ south of the Laboratory, the *Spartina* has just been established. To the north are broad flats of marsh with *Spartina*, *Salicornia*, and *Borrichia*. Where the currents of the water have aided in building up the land the other species mentioned above are to be seen. The town marsh is in a still later stage of development; woody species such as *Myrica cerifera*, and various grasses and herbs, have appeared.

Changes in the small islands of the sound are not all progressive. When the direction of the tidal currents is changed for any reason, the result may be the denudation of land already built up. Such denudation has occurred in a striking way on Bird Shoal, just south of the town of Beaufort. This island was, twenty years or so ago, of an elevation of 15 or 20 feet, and covered with a vigorous growth of plants,

¹*Spartina* has also been planted on Shark Shoal.

including sea oats (*Uniola*), *Myrica cerifera*, and many other species both shrubby and herbaceous. The action of storms, however, combined with changes in the direction of the tidal currents, has resulted in leveling this land until it is now completely covered at mean high tide. The only vegetation now occurring here is a sparse growth of *Spartina glabra*.

Another method of island-formation in neighboring waters has been described by Grave.¹

SAND-BINDING PLANTS

Methods for controlling and reclaiming shifting sands have been well worked out in other regions, and it is known with tolerable certainty just what may be expected of any species of sand-binding plants under given conditions. These conditions are the same the world over. High winds playing over dry sand furnish conditions for plant life that call for specially modified species to withstand them.

In controlling shifting sand, the first step is usually the formation of a barrier dune which will catch and break the full force of the wind; second, the sand back of the dune must be held in place until it can be forested; third, the forest must become established in the lee of the barrier dune.

For forming the barrier dune, beach grass (*Ammophila arenaria*) has been almost universally used. This species is not available at Beaufort. Its place is well supplied, however, by the sea oats (*Uniola paniculata*), which possesses all the features that make beach grass valuable in other localities. Its leaves are sufficiently tough to resist the action of blasts of dry sand driven at high speed. They are too flexible to be broken by direct action of the wind. The root-stocks are strong, heavy, and branching, and strike both vertically and obliquely into the sand, so that the plant is securely anchored, and the sand firmly held. Lastly, the constant movement of the sand is rather beneficial than injurious to *Uniola*.

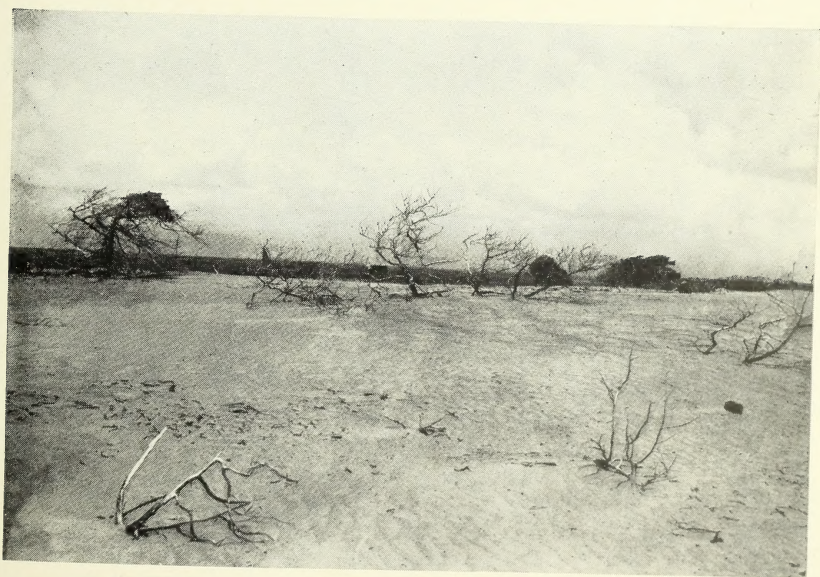
That this species may be successfully used in forming a barrier dune is evidenced by Bogue Bank in the neighborhood of the Hoop Pole wood. Here the dune is stable, and furnishes complete protection to the forest.

The sea oats will prove most valuable in controlling shifting sand. It is not available, however, for reclaiming sandy wastes, for the reason that it flourishes only where the sand is constantly moving. Where the sand, sheltered by a barrier dune, is comparatively stable, other species

¹Grave, C., Investigations for the Promotion of the Oyster Industry in North Carolina; U. S. Fish Commission Report, pp. 260-264. 1903.



A. Sand wall advancing on woodland



B. "Graveyard" of forest, some of the dead trees covered with lianas

are required to hold it in place and, by the addition of humus, to furnish the conditions necessary for a permanent plant covering. Of these species, by far the most valuable in this locality are *Spartina patens* (*S. juncea*) and *Physalis viscosa*. The latter possesses the toughness of leaf necessary to resist the driving particles of sand, and has, in addition, very long, slender, tough, branching root-stocks, which are admirably adapted to hold in place the sand throughout a considerable area around each individual plant. In one plant one of the root-stocks, not including the branches, was found to be upwards of 45 feet in length. Furthermore, *Physalis* is a perennial plant which sets seed freely. *Spartina patens* possesses the same advantages, although the root-stocks are not so long, and is, in addition, more able to resist adverse conditions. The other species which flourish on more or less unstable sand, such as *Euphorbia polygonifolia*, *Croton punctatus*, *Cenchrus tribuloides*, and others, are not so valuable as sand binders, because they lack the extensive branching root-stocks of the two species mentioned first, and because the majority (*Croton punctatus* is an exception to this rule) are annual plants, which are useful only in the summer. One shrubby plant, *Iva oraria*, would prove valuable if it could endure the severe conditions obtaining on sandy areas exposed to the full sweep of the wind; this has not yet been demonstrated. Figure X, B, shows this species forming a stable dune where it is somewhat protected from the wind. Another, *Ilex vomitoria*, is an efficient sand binder and an excellent windbreak when it once gets a foothold. It is difficult to transplant, however, and it is somewhat doubtful whether it would grow from seed in exposed sandy localities. If any reclamation operations are undertaken, efforts should be made to establish it on the exposed sand.

GEOGRAPHICAL DISTRIBUTION OF SHACKLEFORD PLANTS

The entire chain of sandbanks along the North Carolina coast lies in the Austro-riparian area of the Lower Austral Zone.¹ This area includes the coast region beginning from the mouth of the Chesapeake Bay and the coastal plain region of the South Atlantic and Gulf States from North Carolina to Texas, with the exception of the southern extremity of Florida. An analysis of the flora of Shackleford shows the Austro-riparian element to be dominant at this place. Over 24 per cent of the total number of plants listed are characteristic of the flora of this area. These are as follows:

¹See Merriam, The Geographical Distribution of Animals and Plants in North America: Year Book, U. S. Department of Agriculture, 1894, pp. 203-214. Also, Life Zones and Crop Zones of the United States, Bull. 10, Biol. Survey. 1898.

1. Maritime species:

<i>Borrchia frutescens</i> ‡ *	<i>Seutera</i> (<i>Vincetoxicum</i>) <i>palustris</i> † *
<i>Croton punctatus</i> † *	<i>Suaeda</i> (<i>Dondia</i>) <i>linearis</i> † *
<i>Cyperus tetragonus</i> †	<i>Uniola paniculata</i> ‡ *
<i>Eustachys petraea</i> † *	<i>Yucca aloifolia</i> † *
<i>Heliotropium curassivicum</i> ‡ *	—
<i>Physalis viscosa</i> ‡ *	10

2. Species normally occurring near the coast:

<i>Berchemia scandens</i> ‡	<i>Laurocerasus caroliniana</i> †
<i>Callicarpa americana</i> ‡	<i>Lyonia</i> (<i>Pieris</i>) <i>nitida</i> ‡ *
<i>Cicuta curtissii</i> ‡	<i>Osmanthus americanus</i> †
<i>Cissus</i> (<i>Ampelopsis</i>) <i>arborea</i> ‡ *	<i>Panicum lancearium</i> ‡
<i>Cyperus haspan</i> ‡ *	<i>Paspalum distichum</i> ‡ *
<i>Cyperus microdontus</i> ‡ *	<i>Persea borbonia</i> ‡
<i>Fimbristylis spadicea</i> ‡ *	<i>Persea pubescens</i> †
<i>Gaura augustifolia</i> †	<i>Quercus virginiana</i> ‡ *
<i>Gelsemium sempervirens</i> ‡	<i>Rubus trivialis</i> ‡
<i>Ilex vomitoria</i> ‡	<i>Sacciolepis striata</i> ‡ *
<i>Ipomoea sagittata</i> † *	<i>Solanum gracile</i> † *
<i>Iva imbricata</i> ‡ *	<i>Vincetoxicum suberosum</i> ‡
<i>Jatropha stimulosa</i> ‡	<i>Zanthoxylum Clava-Herculis</i> ‡ *
<i>Kneiffia arenicola</i> †	—
<i>Ludvigia alata</i> †	29
<i>Ludvigia microcarpa</i> †	

3. Species occurring normally on the costal plain:

<i>Arenaria lanuginosa</i> † *	<i>Ludvigia virgata</i> †
<i>Cladium jamaicense</i> ‡ *	<i>Paspalum laeve australe</i> ‡
<i>Commelina angustifolia</i> †	<i>Passiflora incarnata</i> ‡ *
<i>Croton glandulosus</i> ‡ *	<i>Polygonum setaceum</i> †
<i>Cynoctonum mitreola</i> ‡ *	<i>Sporobolus indicus</i> ‡ *
<i>Dichromena latifolia</i> ‡	<i>Stenophyllus stenophyllus</i> †
<i>Eleocharis ochreatea</i> ‡ *	<i>Vaccinium arboreum</i> †
<i>Eupatorium capillifolium</i> ‡ *	—
<i>Juncus megacephalus</i> †	16

Total number of strictly Austro-riparian species occurring on Shackleford, 55.

To this list may be added ten species which are stated by Small not to occur north of South Carolina. The ranges quoted are taken from Small's Southern Flora. These species are:

Andropogon tetrastachyus ("South Carolina to Florida and California").

Anychiastrum Baldwinii ("Georgia to Louisiana and Florida").

**Eleocharis microcarpa* ("Florida to Louisiana. Also in Cuba").

**Lagenaria vulgaris* ("Gulf States and throughout the Tropics").

*Also in tropics.

†Northern limit North Carolina.

‡Northern limit Virginia.



A. Dead *Juniperus* covered with lianas



B. View of High Hill from the sound, showing the rise of the land at this point

Lippia nodiflora ("Georgia to Florida").

Paspalum floridanum ("South Carolina to Florida, west to Texas").

Rubus persistens ("South Carolina to Florida and Mississippi").

Rynchospora stipitata ("In river swamps, Florida").

Sabal glabra ("South Carolina to Florida and Louisiana").

**Verbena polystachya* ("Florida, through the Gulf States to California").

Spiranthes ovalis has also not been reported from this State. *Festuca rubra* ranges from Labrador to Virginia, mostly near the coast.

Of the species listed which are not confined to the Austro-riparian area, 27 are maritime and 28 usually occur along the coast. The northern limits of these species are from Nova Scotia to Maryland. With few exceptions they range all along the shores of the South Atlantic and Gulf States.

Of the remaining species, the great majority are weeds of wide distribution, and not confined to or characteristic of any one phytogeographical area. Of these, 137 range practically throughout the United States except on the Pacific slope, while 21 occur throughout the Carolinian and Austro-riparian areas. Leaving out of consideration these species and the wide-ranging strand-forms, it is seen that the flora of Shackleford is almost typically Austro-riparian in its character. The absence of many forms usually occurring in this area¹ is to be attributed, no doubt, to the severe conditions for plant life on the sand banks, since these species are abundant on the mainland, only one to two miles away.

It is worthy of note that the species found also in more northern areas which extend as far south as Beaufort, usually extend also throughout the Austro-riparian area to Florida and the Gulf States. There are only ten exceptions to this rule, or 3 per cent of the whole. In the list the northern and southern limits are indicated in parentheses.

Allium vineale (Connecticut to Georgia).

Amaranthus pumilus (Rhode Island to South Carolina).

Celtis occidentalis (Quebec to North Carolina).

Chenopodium Botrys (Nova Scotia to Georgia).

Digitaria filiformis (Massachusetts to North Carolina).

Festuca rubra (Labrador to Virginia).

Panicum dichotomum (Connecticut to Georgia).

Panicum spretum (New York to Georgia).

Polypogon monspeliensis (New Hampshire to South Carolina).

Vitis labrusca (New England to Georgia).

¹See Kearney, l. c., p. 314.

COMPARISON OF BEAUFORT FLORA WITH THAT OF OTHER LITTORAL REGIONS

	Species	Genera
I. <i>Ocracoke Island</i> (Kearney, l. c.)—		
Total number.....	135	111
Also found at Beaufort.....	107	99
Per cent common to both localities.....	79.2	89.2
II. <i>Isle of Palms, S. C.</i> ¹		
Total number.....	115	96
Also found at Beaufort.....	81	88
Per cent common to both localities.....	70.4	91.6
Per cent common to Ocracoke and Isle of Palms.....	40.8	-----
III. <i>Alabama</i> ² —		
Total number.....	107	83
Also found at Beaufort.....	41	56
Per cent common to both localities.....	38.3	67.4
IV. <i>Florida Keys</i> ³ —		
Total number.....	84 ⁴	76
Also found at Beaufort.....	9	25
Per cent common to both localities.....	10.7	32.9

Of the species listed by Mohr for Alabama, only those are counted here which are stated to occur in the littoral belt. The great majority of Beaufort species occur in the coastal plain region of Alabama, while only 41 per cent are characteristic of the littoral belt. The table serves to show how closely the floras of littoral North and South Carolina approximate, and also how much more nearly similar the floras of Alabama and Beaufort are than those of the Florida Keys and Beaufort. Of the regions compared, the Florida Keys are alone outside the Austro-riparian area.

¹Coker, W. C., Observations on the Flora of the Isle of Palms, Charleston, S. C.; Torreya, V, 135-145, 1905.

²Mohr, C., Plant Life of Alabama; Contributions from the U. S. National Herbarium, VI, 921, pp., 1901.

³Millsbaugh, C. F., Flora of the Sand Keys of Florida; Publications of the Field Columbian Museum, II, 191-245, 1907.

⁴Of these, 62 are confined to Florida and the tropics.



A. Isolated grove of live-oak (*Quercus virginiana*) on mainland; similar to those on Shackleford. (Photo by W. D. Hoyt)



B. Small dune formed by *Iva oraria*; in the foreground is *Spartina patens*

LIST OF SPECIES¹

POLYPODIACEÆ

- i* *Aspidium Thelypteris* (L.) Sw.;
Dryopteris Thelypteris (L.) A. Gray.
e *Asplenium platyneuron* (L.) Oakes.
f† *Onoclea sensibilis* L.
f *Polypodium polypodioides* (L.) Hitch.
f *Pteris aquilina* L.

OSMUNDACEÆ

- f* *Osmunda regalis* L.

PINACEÆ

- e* *Juniperus virginiana* L.
f *Pinus taeda* L.

TYPHACEÆ

- h* *Typha angustifolia* L.

SPARGANIACEÆ

- i** *Sparganium americanum* Nutt. var. *androcladum* (Engelm.) Fern. & Eames.; (*S. androcladum* (Eng.) Morong).

NAJADACEÆ

- Zostera marina* L.

JUNCAGINACEÆ

- h* *Triglochin striata* R. & P.

ALISMACEÆ

- * Saggittaria lancifolia* L.
i *Saggittaria latifolia* Willd.

GRAMINEÆ

- i†* *Andropogon tetrastachyus* Ell.
a, b *Cenchrus tribuloides* L.
Cynodon Dactylon (L.) pers.; (*Ca- priola Dactylon* (L.) Ktze).

Digitaria filiformis (L.) Koeler;
 (Syntherisma filiformis (L.) Nash).

Digitaria sanguinalis (L.) Scop.;
 (Syntherisma filiformis (L.) Nash).

h *Distichlis spicata* (L.) Greene.

i *Echinochloa Walteri* (Pursh.) Nash;
 (*Panicum Walteri* Pursh).

Eleusine indica (L.) Gaert.

Elymus virginicus L.

Eragrostis pectinacea (Michx.) Steud.

a *Eustachys petraea* (Sw.) Desv.;
 (*Chloris petraea* Sw.).

† Festuca rubra* L.

Panicum Sp.

i *Panicum amarum* Ell.

Panicum anceps Michx.

e *Panicum commutatum* Schultes.

e *Panicum dichotomum* L. (?)

Panicum lancerearium Trin. (?);
 (*P. Nashianum* Scribn. (?)).

e *Panicum lanuginosum* Ell.; (*P. pubescens* Lam.).

e *Panicum sphaerocarpon* Ell.

e *Panicum spretum* Schultes(?); (*P. nitidum* Lam. (?)).

i *Panicum virgatum* L.

Paspalum ciliatifolium Michx.

j *Paspalum distichum* L.

† *Paspalum floridanum* Michx.

Paspalum laeve Michx. var. *australe* Nash.

Phleum pratense L.

Polypogon monspeliensis (L.) Desf.

i *Sacciolepis striata* (L.) Nash; (*Panicum gibbum* Ell.).

h *Setaria imberbis* R. & S. var. *perennis* (Hall) Hitch.; (*Chaetochloa versicolor* Bickn.).

g *Spartina glabra* Muhl.; (*S. stricta* (Ait.) Roth.).

a, b *Spartina patens* (Ait.) Muhl. var. *junccea* (Michx.) Hitch.

¹No collections were made later than August, and it is therefore probable that some of the late-blooming species are not included. This applies especially to the Compositæ.

Sporobolus indicus (L.) R. Br.

c *Stipa avenacea* L.

e *Triplasis purpurea* (Walt.) Chapm.;
(*Sieglingia purpurea* (Walt.)
Ktze.).

e *Uniola laxa* (L.) B. S. P.

b *Uniola paniculata* L.

Muhlenbergia capillaris Curtis.

CYPERACEÆ

i *Cladium jamaicense* Crantz; (C.
effusum (Sw.) Torr.).

i *Cyperus cylindricus* (Ell.) Britton.

i *Cyperus ferax* Rich.; (C. *speciosus*
Vohl.).

i *Cyperus flavescens* L.

i *Cyperus haspan* L.

i *Cyperus microdontus* Torr.

h *Cyperus Nuttallii* Eddy.

*i** *Cyperus retrofractus* (L.) Torr.

i *Cyperus strigosus* L.

i *Dichromena colorata* (L.) Hitch.

*i** *Dichromena latifolia* Baldw.

i *Dulichium arundinaceum* (L.) Britton.
ton.

h *Eleocharis albida* Torr.

i *Eleocharis microcarpa* Torr.

h *Eleocharis ochreate* (Nees) Steud.

h *Eleocharis Robinsii* Oakes. (?)

Fimbristylis autumnalis (L.) R. & S.

h *Fimbristylis castanea* (Michx.)
Vahl.

h *Fimbristylis spadicea* (L.) Vahl.

i *Fuirena hispida* Ell.

i *Rynchospora glomerata* (L.) Vahl.

*i** *Rynchospora stipitata* Chapm.

h *Scirpus americanus* Pers.

h *Scirpus validus* Vahl.; (S. *lacustris*
Am. auth.).

f *Scleria triglomerata* Michx.

f *Stenophyllus stenophyllus* (Ell.)
Britton.

PALMÆ

*f** *Sabal glabra* Mill.) Sarg.; (S. *Adansonii* Guerns.).

ARACEÆ

i *Acorus Calamus* L.

XYRIDACEÆ

*d** *Xyris arenicola* Small; (X. *torta*
J. E. Smith).

COMMELINACEÆ

Commelina sp.

d *Commelina angustifolia* Michx.

JUNCACEÆ

Juncus marginatus Rostk.

h *Juncus megacephalus* Curtis.

h *Juncus Roëmerianus* Scheele.

f *Juncus setaceus* Rostk.

f *Juncus tenuis* Willd.

LILLIACEÆ

* *Allium vineale* L.

e *Smilax Bona-nox* L.

e *Smilax glauca* Walt.

e *Smilax laurifolia* L.

d *Yucca aloifolia* L.

ORCHIDACEÆ

Spiranthes ovalis Lindl. (?); (*Gyro-*
stachys parviflora (Chapm.)
Small (?)).

PIPERACEÆ

*i** *Saururus cernuus* L.

SALICACEÆ

i *Salix* sp.

MYRICACEÆ

d *Myrica carolinensis* Mill.

e *Myrica cerifera* L.

JUGLANDACEÆ

*f** *Carya glabra* (Mill.) Spach.; (*Hico-*
ria glabra (Mill.) Britton).

BETULACEÆ

f *Carpinus caroliniana* Walt.



Ilex vomitoria as a wind-break in exposed localities

FAGACEÆ

- f** *Quercus falcata* Michx.; (*Q. digitata* Sudw.).
f *Quercus nigra* L.; (*Q. aquatica* Walt.).
f *Quercus phellos* L. var. *laurifolia* (Michx.) Chapm.
*f** *Quercus stellata* Wang.; (*Q. minor* (Marsh) Sarg.).
e, f *Quercus virginiana* Mill.

URTICACEÆ

- i* *Boehmeria cylindrica* (L.) Sw.
Celtis occidentalis L.
f *Morus rubra* L.
i *Parietaria floridana* Nutt.
i *Pilea pumila* (L.) Gray; (*Adicea pumila* (L.) Raf.).

LORANTHACEÆ

- f* *Phoradendron flavescens* (Pursh.) Nutt.

POLYGONACEÆ

- i* *Polygonum acre* H. B. K. var. *leptostachyum* Meisn.; (*P. punctatum* Ell. var. *leptostachyum* (Meisn.) Small).
Polygonum lapathifolium L.
a *Polygonum maritimum* L.
i *Polygonum setaceum* Baldw.
 * *Rumex hastatulus*

CHENOPODIACEÆ

- a* *Atriplex arenaria* Nutt.
Atriplex patula L. (?)
a *Chenopodium anthelminticum* L.
a *Chenopodium Botrys* L.
a *Chenopodium glaucum* L.
a *Chenopodium viride* L.
g *Salicornia ambigua* Michx.
g *Salicornia mucronata* Bigel.; (*S. Bigelowii* Torr.).
a, b *Salsola Kali* L.
h *Suaeda linearis* (Ell.) Moq.; (*Dondia linearis* (Ell.) Millsp.).

AMARANTHACEÆ

- e* *Acnida cannabina* L.
b *Amaranthus pumilus* Raf.

PHYTOLACCACEÆ

- Phytolacca decandra* L.

AIZOACEÆ

- a* *Sesuvium maritimum* (Walt.) B. S. P.

CARYOPHYLLACEÆ

- f* *Arenaria lanuginosa* (Michx.) Rohrb.
e† *Anychiastrum Baldwinii* (T. & G.) Small.

PORTULACACEÆ

- a* *Portulaca oleracea* L.

MAGNOLIACEÆ

- f* *Magnolia virginiana* L.

LAURACEÆ

- e, f* *Persea borbonia* (L.) Spreng.
e, f *Persea pubescens* (Pursh) Sarg.
f *Sassafras variifolium* (Salisb.) Ktze.; (*S. officinale* Nees. and Eberm.).

CRUCIFERÆ

- f* *Lepidium virginicum* L.

ROSACEÆ

- Laurocerasus caroliniana* (Mill.) Roem.
Rosa carolina L.
d *Rubus trivialis* Michx.
 † *Rubus persistens* Rydb. (?)

LEGUMINOSÆ

- f* *Apios tuberosa* Moench.
d *Cassia chamaecrista* L.
e *Desmodium paniculatum* (L.) DC.; (*Meibomia paniculata* (L.) Ktze.).

- e* Galactia volubilis (L.) Britton.
e Strophostyles umbellata (Muhl.)
 Britton.
Trifolium repens L.

LINACEÆ

- f* Linum medium (Planch.) Britton.

RUTACEÆ

- e* Zanthoxylum Clava-Herculis L.

SIMARUBACEÆ

- f* Ailanthus glandulosa Desf.

MELIACEÆ

- Melia Azedarach* L.

POLYGALACEÆ

- i* Polygala verticillata L.

EUPHORBIACEÆ

- e* Acalypha gracilens Gray.
d Croton glandulosus L. var. septentrionalis Muell. Arg.
a, b Croton punctatus Jacq.
f Euphorbia sp.
a Euphorbia maculata L.
b Euphorbia polygonifolia L.
f Jatropha stimulosus Michx.
Ricinus communis L.

ANACARDIACEÆ

- Rhus copallina* L.
e, f *Rhus toxicodendron* L. var. *radicans*
 Torr.

AQUIFOLIACEÆ

- e* Ilex glabra (L.) Gray.
f Ilex opaca Ait.
d, e, f Ilex vomitoria Ait.

RHAMNACEÆ

- e, f* Berchemia scandens (Hill) Trel.

VITACEÆ

- e* Cissus arborea (L.) Des. Moul.;
 (Ampelopsis arborea (L.)
 Rusby).

- e* Psedera quinquefolia (L.) Greene;
 (Parthenocissus quinquefolia (L.)
 Planch.).

- e* Vitis aestivalis Michx.
e Vitis labrusca L.
e Vitis rotundifolia Michx.

TILIACEÆ

- f* Tilia Michauxii Nutt.; Tilia pubescens Ait.).

MALVACEÆ

- i* Kosteletzkya virginica (L.) Presl.

TAMARICACEÆ

- Tamarix gallica* L.

HYPERICACEÆ

- e* Ascyrum hypericoides L.
e Hypericum mutilum L.
i Hypericum virginicum L.; (Triadenum virginicum (L.) Raf.).

CISTACEÆ

- e, f* Lechea villosa Ell.

PASSIFLORACEÆ

- e* Passiflora incarnata L.
e Passiflora lutea L.

CACTACEÆ

- d* Opuntia vulgaris Mill.; (Opuntia opuntia (L.) Coult.).

LYTHRACEÆ

- i* Amannia Koehnei Britton.
*i** Decodon verticillatus (L.) Ell.
i Lythrum lineare L.

ONAGRACEÆ

- d* Gaura angustifolia Michx.
d Kneiffia arenicola Small.
i Ludvigia alata Ell.
i Ludvigia microcarpa Michx.
i Ludvigia palustris (L.) Ell.; (Isnardia palustris L.).

- i* *Ludvigia virgata* Michx.
c *Oenothera humifusa* Nutt.

HALORAGIDACEÆ

- i** *Myriophyllum verticillatum* L.
i *Proserpinaca pectinata* Lam.

ARALIACEÆ

- f* *Aralia spinosa* L.

UMBELLIFERÆ

- h* *Centella asiatica* (L.) Urban.; (*C. repanda* (Pers.) Small).
f *Cicuta Curtissii* Coult. & Rose.
h *Hydrocotyle umbellata* L.
i *Hydrocotyle verticillata* Thunb.
h *Lilaeopsis lineata* (Michx.) Greene.
h *Ptilimnium capillaceum* (Michx.) Raf.
e *Sanicula canadensis* L.

CORNACEÆ

- f* *Cornus florida* L.

ERICACEÆ

- f** *Lyonia nitida* (Bartr.) Fernald;
 (*Pieris nitida* (Bartr.) B. & H.).
*f** *Vaccinium arboreum* Marsh.

PLUMBAGINACEÆ

- h* *Limonium carolinianum* (Walt.) Britton.

PRIMULACEÆ

- h* *Samolus floribundus* HBK.

EBENACEÆ

- f* *Diospyros virginiana* L.

OLEACEÆ

- f* *Osmanthus americana* (L.) B. & H.

LOGANIACEÆ

- i* *Cynoctonum mitreola* (L.) Britton.
e *Gelsemium sempervirens* (L.) Ait. f.

GENTIANACEÆ

- h* *Sabatia stellaris* Pursh.

APOCYNACEÆ

- e* *Apocynum cannabinum* L.

ASCLEPIADACEÆ

- i* *Asclepias lanceolata* Walt.
h *Seutera palustris* (Pursh.) Vail;
 (*Vincetoxicum palustre* (Pursh.) Gray).
e *Vincetoxicum suberosum* (L.) Britton.

CONVOLVULACEÆ

- i* *Cuscuta arvensis* Beyrich.
i *Ipomoea sagittata* Cav.

BORAGINACEÆ

- a* *Heliotropium curassavicum* Cav.

VERBENACEÆ

- e* *Callicarpa americana* L.
i *Lippia nodiflora* (L.) Michx.
*i** *Verbena polystachya* HBK.

LABIATÆ

- Marrubium vulgare* L.
e, f *Monarda punctata* L.
 * *Teucrium canadense* L. var. *littorale*
 (Bicknell) Fernald.
i *Trichostema dichotomum* L.

SOLLANACEÆ

- Datura Stramonium* L.
a *Physalis pubescens* L.
a *Physalis viscosa* L.
a *Solanum carolinense* L.
a *Solanum gracile* Link.

SCROPHULARIACEÆ

- h* *Bacopa Monniera* (L.) Wettst.;
 (*Monniera Monniera* (L.) Britton).
h *Gerardia maritima* Raf.
Verbascum Thapsus L.

LENTIBULARIACEÆ

- †* *Utricularia purpurea* Walt.

PLANTAGINACEÆ

- * *Plantago lanceolata* L.

RUBIACEÆ

- i* *Diodia virginiana* L.
i *Diodia teres* Walt.
e *Galium hispidulum* Michx.
e *Galium pilosum* Ait. var. *puncticulosum* (Michx.) (T. & G.).
e *Mitchella repens* L.

CAPRIFOLIACEÆ

- e* *Lonicera sempervirens* L.

CUCURBITACEÆ

- a* *Lagenaria vulgaris* Ser.; (*Lagenaria Lagenaria* (L.) Cock.).
d, e *Melothria pendula* L.

AMBROSIACEÆ

- f* *Ambrosia artemisiifolia* L.
a *Iva oraria* Bartl.; (*I. frutescens* L.).
a *Iva imbricata* Walt.
a *Xanthium* sp.

CICHORIACEÆ

- e* *Hieracium Gronovii* L.
f *Lactuca canadensis* L.
 * *Sonchus asper* (L.) Hill.

CARDUACEÆ

- a* *Baccharis halimifolia* L.
Bidens bipinnata L.
g *Borrchia frutescens* (L.) DC.
 * *Carduus* sp.
e *Cirsium spinosissimum* (Walt.) Scop.; (*Carduus spinosissimus* Walt.).
i *Eclipta alba* (L.) Hassk.
e, f *Elephantopus nudatus* Gray.
e *Erechthites hieracifolia* (L.) Raf.
e *Erigeron canadensis* L.; (*Leptilon canadensis* (L.) Britton).
Eupatorium capillifolium (Lam.) Small.
Heterotheca subaxillaris (Lam.) Britton and Rusby.
e, i *Mikania scandens* (L.) Willd.; (*Willughbaea scandens* (L.) Ktze.).
i *Pluchea camphorata* (L.) DC.
i *Pluchea foetida* (L.) B. S. P.
Senecio vulgaris L.
f *Solidago odora* Ait.
e *Solidago sempervirens* L.

*Not collected on Shackleford, but on some of the neighboring islands.

†Range here extended.

‡Listed by Johnson⁽²⁾, not observed by the writer.

*a*Characteristic of the inner beach formation.

*b*Outer beach formation.

*c*Dune formation.

*d*Thicket formation.

*e*Thicket woodland formation.

*j*Woodland formation.

*g*Salt marsh formation.

*h*Creek Marsh formation.

*i*Dune marsh formation.

*j*Tidal flat formation.

²Johnson, D. S., Notes on the Flora of the Banks and Sounds at Beaufort, N. C.: Bot. Gazette, 30, 405-409, 1906.

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
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24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs., 1 map. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Postage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virginiana Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

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32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Out of print.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreal,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 64 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. 8°, 90 pp. *Postage 10 cents.*

46. The Vegetation of Shackleford Bank, by I. W. Lewis, 1917. 8°, 40 pp., 11 plates. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention. Held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Greensboro, N. C., November 22 and 23, 1916. ... pp., ... figs. *Postage ... cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 —pl., 188 figs. *Postage 35 cents. Price \$1.50.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The water resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. The Birds of North Carolina—*In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes. State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp.
Postage 1 cent.

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in

Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 20 cents.*

Administrative Report.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 47

PROCEEDINGS

OF THE

NINTH ANNUAL DRAINAGE CONVENTION

OF THE

NORTH CAROLINA DRAINAGE ASSOCIATION

HELD AT

GREENSBORO, NORTH CAROLINA

NOVEMBER 22 AND 23, 1916

COMPILED BY

JOSEPH HYDE PRATT, State Geologist

AND

MISS H. M. BERRY, Secretary



RALEIGH

EDWARDS & BROUGHTON PRINTING CO.

STATE PRINTERS

1917

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1917.

To His Excellency, HON. T. W. BICKETT,
Governor of North Carolina.

SIR:—On November 22d and 23d, 1916, there was held at Greensboro, North Carolina, the Ninth Annual Convention of the North Carolina Drainage Association. Because of the importance of the drainage of our swamp and overflowed lands to the development of North Carolina, the value of this work, as shown in the papers and discussions at the Convention, is such that we recommend the publication of these Proceedings by the Survey. They are herewith submitted as Economic Paper No. 47, of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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INTRODUCTION

Since its organization, the North Carolina Drainage Association has worked in close coöperation with the North Carolina Geological and Economic Survey; and, in arranging for the Ninth Annual Convention, which was held at Greensboro, November 22 and 23, 1916, the work was done by these two agencies. It is largely through these conventions and the articles sent to the press by the Association and the Survey that public opinion has been awakened to the great importance to the State of the drainage of the wet lands, including both the swamp lands of the Coastal Plain and the overflowed lands of the Piedmont and mountain regions.

At the Eighth Annual Convention it was decided to emphasize the subject of Tile Drainage, and, with this in view, the following letter regarding tile drainage contests among the boys of the agricultural clubs and among North Carolina farmers was prepared and sent to the press, together with rules and regulations governing these contests:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., September 29, 1916.

To the Editors of the North Carolina Press.

DEAR SIR:—Enclosed I am sending you two notices in regard to Tile Drainage Contest for boys of the Agricultural Clubs and for farmers of the State. These contests are to be conducted under the auspices of the North Carolina Drainage Association at its annual convention, which is to be held at Greensboro, North Carolina, November 22 and 23.

The use of tile drainage in this State will undoubtedly add an almost unbelievable amount to the agricultural values of many of our lands, and the spread of this propaganda will mean much to the advancement of the agricultural interests of the State. I am, therefore, requesting the newspapers to print these notices in full at a very early date so that as many of our farmers and members of the Boys' Agricultural Clubs as possible can learn of the contest and make plans for entering it. By doing this we feel that you will render a real service to your county and to the State generally.

We appreciate the coöperation which the press of the State has given in advancing the cause of drainage, and bespeak your further coöperation in taking a step further to disseminate this information about tile drainage, which is now considered so essential to securing the best results from many of our farm lands.

With best wishes, I am

Cordially yours,

JOSEPH HYDE PRATT,
Secretary.

NORTH CAROLINA DRAINAGE ASSOCIATION

Press Notice.

CHAPEL HILL, N. C., September 29, 1916.

TILE DRAINAGE CONTEST FOR BOYS' AGRICULTURAL CLUBS

ANNOUNCEMENT AND RULES GOVERNING CONTEST

The North Carolina Drainage Association wishes to encourage the young men of the State in underdrainage of their wet lands in order that they may receive maximum yields with minimum effort; and that the educational value of the club work may be enhanced. To this end the Association offers a gold medal to the member of the Boys' Agricultural Clubs who submits the most approved plan for the underdrainage of a field or portion of a field.

The following rules apply:

1. The field may be of any size from one acre up and may be selected by the contestant from any land in which he is interested.

2. The plans shall consist of:

(a) A description of the field, including location, acreage, shape, topography, description of the soil and subsoil, present use of the land and present conditions as regards natural drainage.

(b) A drawing or sketch showing the shape of the field, location and arrangement of proposed drains, location of the canal, creek, or open ditch into which the proposed drains are to discharge, and any other points mentioned in the description.

(c) Number of feet of tile required for each line, with size and cost of tile, and estimated cost of digging and backfilling the ditches.

(d) Estimated cost per acre.

3. The plans must represent or express the contestant's own ideas in adapting a system of drainage to the field selected, though he may consult others in making his plans and will be furnished needed information upon application to the Vice-President in Charge of Tile Drainage (Prof. M. E. Sherwin, West Raleigh, N. C.).

4. The plans shall be mailed to the Secretary of the North Carolina Drainage Association (Dr. Joseph Hyde Pratt, Chapel Hill, N. C.), so that it shall be in his hands before the time of the Annual Convention of the Association which is to be held in Greensboro, N. C., November 22 and 23, 1916; or shall be filed with the Secretary on the first day of the Convention.

5. The contestant shall not be obligated to construct the drains as planned, though their construction would probably be profitable.

6. The plans shall be judged by a committee appointed by the President of the Association, and the award shall be made in open session of the Convention.

NORTH CAROLINA DRAINAGE ASSOCIATION

Press Notice.

CHAPEL HILL, N. C., September 29, 1916.

A TILE DRAINAGE CONTEST FOR NORTH CAROLINA FARMERS

ANNOUNCEMENT AND RULES GOVERNING CONTEST

To stimulate interest among the farmers of the State and to aid in the dissemination of information regarding the benefits of tile drainage, the North

Carolina Drainage Association offers a prize of \$10 to the farmer who submits the best report of benefits actually received from tile drains.

The following rules apply:

1. The area reported upon may be of any size, shape, and location within the State.

2. The report shall include:

(a) A description of the field, including location, acreage, shape, topography, and description of the soil and subsoil.

(b) A statement of the drainage conditions before the tile drains were constructed and the crops grown (if any), with approximate or accurate yields received.

(c) A statement of the present drainage conditions and crops grown, with approximate or accurate yields received.

(d) A drawing or sketch showing the shape of the field, location and arrangement of tile drains, location of canal, creek, or open ditch into which the drains discharge, and height of water in the same, and any other points mentioned in the description.

(e) Number of feet and size of tile used, cost of tile, and cost of digging and backfilling the ditches.

(f) Total cost per acre.

3. The report shall be mailed to the Secretary of the North Carolina Drainage Association (Dr. Joseph Hyde Pratt, Chapel Hill, N. C.), so that it shall be in his hands before the time of the Annual Convention of the Association which is to be held in Greensboro, N. C., November 22 and 23, 1916; or shall be filed with the Secretary on the first day of the Convention.

4. The report shall be judged by a committee appointed by the President of the Association, and the award shall be made in open session of the Convention.

The following letter was sent to the farmers of North Carolina, through the Bureau of Extension of the Department of Agriculture at Raleigh, together with the rules governing this contest.

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., September 29, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association will be held at Greensboro, N. C., November 22 and 23, and I sincerely hope that you are going to be able to attend. One of the subjects to be emphasized at this Convention is Tile Drainage, and we are arranging for Tile Drainage Contests among the boys of the Agricultural Clubs and also among the farmers of the State. I am inclosing herewith copy of the rules and regulations governing the contest for farmers, and sincerely hope that you will become interested and will take part in it. We believe this to be a most important phase of drainage work and worthy of very serious consideration on the part of our farmers, if they hope to obtain the greatest value from a considerable portion of their lands.

Arrangements for the program have not yet been completed; but as soon as they are I will write you more fully regarding the Convention. I am send-

ing this preliminary notice so that you will have an opportunity to take part in the contest and to get ready for the Convention. Delegates are invited to make exhibits consisting of pictures of their lands before and after drainage, and of growing crops, maps, charts, and samples of crops from drained lands. If you know of any other persons in your neighborhood who would like to attend the Convention or take part in this contest, I will appreciate your sending me their names and addresses.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,
Secretary.

In arranging for the Convention, the following letter was sent to the chairman of the boards of county commissioners, asking them to appoint delegates to represent their respective counties; to the mayors of cities and towns for the appointment of delegates to represent their municipalities; to the presidents of boards of trade and chambers of commerce for the appointment of delegates to represent their bodies; and to the commissioners of drainage districts already established, for the appointment of delegates to represent their individual districts:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., October 20, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, North Carolina, November 22 and 23. The drainage of the swamp and overflowed areas of the State has become a tremendously important factor in the reclamation of these waste lands; in rendering them more healthful and hence more habitable; and in adding enormously to their economic value. The North Carolina Drainage Association has been the principal factor in developing public sentiment so as to make possible the passage of the North Carolina Drainage Law, and at its annual conventions there have been free discussions of topics relating to drainage which have been of great value to those connected with the drainage work. As a result of this drainage work there have been reclaimed in the swamp areas approximately 800,000 acres in 59 districts. The reclamation of these lands means that land which was formerly bringing in no revenue to the owner is now producing from 20 to 100 bushels of corn to the acre, from 1 to 2 bales of cotton, and other crops in like proportion. In the Piedmont section of the State the overflowed lands along the creeks and rivers are being reclaimed, and 60 of these districts have been organized.

In addition to the reclamation of these waste lands, the North Carolina Drainage Association is interested in increasing the yield of all farm lands in so far as this may be done by drainage; and, for this reason, is seeking to interest our farmers in tile drainage, terracing, etc. To this end the Association is offering to the farmers of the State a prize of \$10 for the best report on results obtained from tile drainage; and to the boys of the Agricultural Clubs a gold medal for the best plan for a tile-drained field.

I am writing to extend to you a most cordial invitation to attend the Convention at Greensboro as a delegate, and to ask that you appoint *ten other*

delegates to represent your county at the Convention. We want to have full discussions of the North Carolina Drainage Law and such amendments as may seem to be needed to make it more effective. All delegates are earnestly invited and urged to bring up any suggestions they may have in regard to amendments to the law. It is believed that a full discussion of all the difficulties met with in connection with our drainage operations—whether due to the inelasticity of the law or to difficulties met with in the sale of bonds, or whatever the problem may be—will yield a resulting benefit to our drainage work.

I sincerely hope that you will make a special effort to attend the Convention and will urge those whom you appoint as delegates to attend. Please send me the names and addresses of those whom you appoint.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,

Secretary.

The following letters of notification and information in regard to program, arrangements for delegates, exhibits, etc., were mailed to all delegates appointed, and also to the members of the North Carolina Drainage Association:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., November 1, 1916.

DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, November 22 and 23, and I sincerely hope that you can arrange to attend. We are inviting those directly interested in drainage districts to bring pictures to the Convention illustrating their drainage work and results obtained from the lands after drainage. I believe samples of products from these lands would likewise be of interest.

I also hope you can prepare a brief written report to submit to the Convention as to what has been accomplished in your district. If you cannot be present at the Convention, I hope you can send such written report to me ahead of time to submit to the Convention. We will send you further information in regard to program for the Convention later.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,

Secretary.

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., November 10, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, N. C., November 22 and 23, and you have been appointed a delegate to this Convention. I sincerely hope that you can make your arrangements to attend, as I believe it will be the most important Convention we have yet held. The drainage work of the State is becoming each year of more value to our people, and we feel that at these annual meetings many subjects are discussed which are of vital importance

to those who are engaged in this drainage work. At this meeting the principal subjects to be discussed are:

Tile Drainage, under which head will be included other forms of farm drainage, such as terracing, etc.; the North Carolina Drainage Law, with a view to amendments which should be made by the Legislature of 1917; reports of representatives from Drainage Districts; Maintenance of Drainage Ditches; Drainage Bonds; the Financing of Drainage Projects with reference to the Federal Farm Loan Banks, etc.

In connection with the Tile Drainage Session, there will be reports from farmers who have installed tile drainage successfully, there will be a trip to the plant of the Pomona Terra Cotta Company, where tile drain is made; and it is expected that there will be a demonstration of a six-horse ditching machine and a traction ditcher; and other features which will be of interest to those who are connected with drainage work.

We want to make this the best Convention that we have ever held, and in order for it to be a success we must have a large and interested attendance.

Headquarters of the Convention will be the Guilford Hotel. Other hotels are the Clegg, Huffine, Carolina, and Blandwood. These are all European plan. Reservations for rooms should be made ahead of time. The meetings will be held in the Elks' Club, which is diagonally across the street from the Guilford Hotel.

I sincerely hope that you can plan to be present for the two full days, and if you know of others in your neighborhood who would like to attend, we would be glad to appoint them as delegates also, if you will send in their names and addresses.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,
Secretary.

There was also sent to the press and to delegates appointed the following notice in regard to the Convention:

CHAPEL HILL, N. C., November 8, 1916.

NORTH CAROLINA DRAINAGE CONVENTION
GREENSBORO, N. C.

NOVEMBER 22 AND 23, 1916.

The Ninth Annual Convention of the North Carolina Drainage Association will be held at Greensboro, November 22 and 23, with headquarters at the Guilford Hotel. The meetings will be held in the Elks' Club. All citizens who are interested in the reclamation of the swamp lands of the coast or overflowed areas in central and western North Carolina are most cordially invited to attend the sessions of the Convention.

The object of the reclamation of these lands is threefold: (1) to increase the healthfulness in the section of the country in which the swamp or overflowed areas exist; (2) to make a nonproducing area productive, and thus add to the revenue of the Commonwealth; (3) to facilitate intercourse between communities adjacent to these swamp areas by the construction of roads, which always follows the drainage of any swamp area.

Up to the present time, about 122 drainage districts have been organized to reclaim between 800,000 and 1,000,000 acres of land which, before drainage, was not only unproductive, but a menace to the health of the community. Before drainage these lands were listed at from 25 cents to \$1 per acre. After being drained and cleared the land is worth from \$50 to \$150 and more per acre. The cost of drainage varies from \$4 to \$6 per acre in the swamp district to \$15 to \$25 per acre in the Piedmont.

Problems connected with the drainage of these areas will be discussed at the Convention, as well as further amendments to the drainage law. The Association, however, has undertaken further educational work in connection with drainage, which relates especially to farm drainage, such as tile drainage, terracing, etc. Prizes are being offered by the Association at this Convention to the farmer who will submit the best report of benefits actually received through tile drainage, and to a member of the Boys' Agricultural Clubs for the most approved plan for the underdrainage of a field or a portion of a field. Rules governing these contests have been mailed to farmers who have undertaken tile drainage and to members of the Boys' Agricultural Clubs. It is expected that this will be the means of awakening a widespread interest in this form of drainage, which means so much in increasing the productivity of a great deal of the farm lands of the State.

The delegates to the Convention will have the privilege of inspecting the plant of the Pomona Terra Cotta Company, where tile drain is being manufactured, and it is expected that we will be able to have a demonstration of a six-horse power ditching machine, and a traction ditcher.

There will be discussions from representatives of bond houses in regard to such changes as they may think should be made in the drainage law to make the drainage bonds more salable. There will also be discussions in regard to the financing of drainage districts with reference to the farm loan banks.

As stated above, every citizen in the State who is interested in this vast project of conservation and reclamation is cordially invited to attend the sessions of the Convention and take part in the proceedings.

JOSEPH HYDE PRATT,

Secretary, N. C. Drainage Association.

PROCEEDINGS
OF THE
NINTH ANNUAL CONVENTION
OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION

GREENSBORO, N. C., NOVEMBER 22-23, 1916

WEDNESDAY, NOVEMBER 22, 1916—Morning Session

The Convention was called to order by the President, Mr. P. H. Johnson, at 10 a. m. in the Courthouse. The Convention was opened with prayer by the Rev. C. F. Murray of Greensboro, as follows:

"O Lord, Thou art a spirit, infinite, eternal, unchangeable. We stand in Thy presence this morning and recognize Thee as the author and finisher of every good work. We come as co-laborers with Thee in this, a part of our work. We ask Thee to bless this Convention. May we be linked up with the Lord Almighty; wilt Thou continue to smile in approval upon us. May we measure up to the fullness of our gifts. We ask it in Christ's name. Amen."

ADDRESS OF WELCOME ON BEHALF OF THE CITY OF GREENSBORO

HON. N. L. EURE:

Mr. Chairman and Gentlemen: The Mayor, in his absence, has asked me to come up here this morning and to extend a hearty welcome to you gentlemen to our city, and I want to say to you that we are always delighted to have good citizens come among us, and especially are we very much delighted this morning to have you gentlemen come here and assemble in our midst for this great purpose which you have come; that is, to look after the general drainage work of the State of North Carolina. There are a good many things I might say. I know very little of the drainage question of North Carolina, but I do know that you gentlemen are here in the interest of the welfare of the State, and to give it greater wealth, and broader acres for cultivation, and we are especially delighted to have you come here among us for such a great purpose, and we trust that your stay here will be exceedingly pleasant and that you may get more out of this meeting than any held heretofore; that your deliberations may mean much for the State of North Carolina now and in the future. It gives me very much pleasure indeed to extend a hearty welcome to you, and we trust that you will have a very good time while you are here. I give you this welcome in the name of the City of Greensboro.

ADDRESS OF WELCOME FROM THE CHAMBER OF COMMERCE
OF GREENSBORO

HON. C. L. BROOKS, President:

Mr. Chairman, Lady and Gentlemen: On behalf of the Chamber of Commerce of Greensboro and the business interests of this city, I desire to extend to you a most cordial welcome to our city. It has been counted as the greatest achievement of statesmanship in the past when a man or set of men could make two blades of grass grow where only one grew before; but I am convinced that it is a very much greater thing for a man or set of men to make many blades of grass grow where none grew before—such as you gentlemen are doing. You are engaged, in my opinion, in perhaps the most interesting, far-reaching, and constructive character of work that any set of men engaged in secular business in North Carolina are now at work on. You are not only reclaiming a great deal of waste land, but you are at the same time rendering the State a distinct service along its health lines. There is nothing more beautiful in nature than the creation of something new; that is why man, since he first became civilized, has tipped his hat to the mother who gives to the world a strong child; and the men in a State such as North Carolina, where most of those in the past have thought all was done that could be done, are glad to see that they are a set of forward-looking, progressive citizens who have conceived this great work of reclaiming for the State, as if from the grave, what I understand by some is considered as worth fifty millions of dollars; and of course with the development of our resources and the general increase in values, this fifty million dollars will go on to the hundred and fifty million dollars, because I believe North Carolina is just now in the infancy of its development. It was an inspiration to the people of North Carolina and to us here—because I speak for a very progressive city—to know that you gentlemen could band yourselves together in this work, realizing that the duties and obligations which your fathers owed to the State and the Nation and the world was a limited one as compared with the obligations and opportunities that you have this day to perform. Mr. Wilson, in a recent address, stated that 50 per cent of all the gold in the world was now in the coffers of the United States vaults; that if this war should last another year, perhaps two-thirds of all the gold of the world would be in the United States. The Minister of Finance of France, in a recent address, said that the total cost of the war up to the present time was something like one hundred and forty billions of dollars, and if it should last fifteen months longer that every nation engaged in the war would be bankrupt.

North Carolina has had a very distinguished and important part pressed upon her in the great arena of the world's activity, and I am glad to say to you here today that to a man she has played well her part, not only in the arts of war, but in the paths of peace, and in this reclamation of our land, which at the last is the State's best resource, you have played well your part, so that you can further not only this great work, but encourage others to achievement when their attention is turned to other things, which have helped not only North Carolina, but the Nation as well, through constructive citizenship.

Will you permit me, in conclusion, to say that you gentlemen in this work have been of inestimable benefit to the State, and it is through your efforts

that a great work has been accomplished, for North Carolina did not take it up until you conceived it and carried it out. May I call your attention to an observation of Isaiah, in the 35th chapter and 1st verse: "The wilderness and the solitary places shall be glad for Thee, and the desert shall rejoice and blossom as a rose." It is a great work that you are engaged in; may you keep it up, and Greensboro and her business men bid you Godspeed.

ADDRESS OF WELCOME ON BEHALF OF GUILFORD COUNTY

MR. W. C. BOREN, Chairman Board of County Commissioners:

Mr. Chairman, Miss Berry, and Gentlemen: I am glad I came last on the program, because you won't expect to hear much from a plain countryman after two distinguished lawyers have spoken. I only wish to say we are certainly pleased to have you with us. We know the importance of this great work, and are glad to see it going on. Guilford County has not done much in that direction, as in the drainage of the larger districts of the east; in fact, we have not many in that shape. While you are here we want to show you some of our good roads and factory places, etc. We will be very glad to have you go with us over Guilford County, and will do all that we can to make it pleasant for you.

RESPONSE TO ADDRESS OF WELCOME

P. H. JOHNSON, President, North Carolina Drainage Association:

Miss Berry, Gentlemen of Greensboro and Gentlemen of the Convention: I would ask for no pleasanter duty than that which devolves upon me as President of the Association to respond to the kind words of welcome with which we have just been greeted. I am grateful for the opportunity which this Convention presents for me to visit your good city and come in touch with your representative men. I wish that I might be able to express our appreciation of your kindness in words as graceful as those which have been employed by the distinguished gentlemen who have preceded me, but being only an humble farmer, I find myself very much like an Armenian who entered a northern university. He understood English pretty well, but he could not always find words to fit his ideas. When he had an idea he could not express, he would say, "I know, but I cannot express." One day a professor asked the question, "What is a vacuum?" He looked up hopefully, and said, "I have it in my head, but I cannot express." That is my position this morning; but I say to you, gentlemen of Greensboro, that in lending your presence and your aid and your counsel to this Convention, you are emphasizing a spirit which is characteristic of every true North Carolinian today, in that you are teaching us that you recognize that community of interest which prevails throughout the commercial, professional, social, and religious life of our State. We have recently seen a striking illustration of the fact that North Carolinians regard themselves as their brothers' keeper. When just a few months ago the mighty waters defied man power to bind them, and swept with such fury over fertile valleys and happy hillsides, carrying desolation and death in their wake, it was good to know that there was not a man of any station in North Carolina whose heart was not touched with sorrow on account of this appalling calam-

ity. It is good to believe that in this instance sympathy was not confined to any creed or condition. The simple toiler mingled his tears and his prayers with those of his more favored brother, and the sympathetic heart-throb in the bosom of the western mountaineer found echo in the bosom of the toiler by the sea; and when a call for aid was issued, it is good to know that North Carolinians responded with a unity of purpose unequalled perhaps since the days when our Confederate soldiers came home bereft of everything except courage, and faced the desolation which war had made, but with the determination to restore to the State her former glory—that State for love of which they had sacrificed their all.

My friends, to my mind this is a momentous occasion in the city of Greensboro. During the course of events I know that you have entertained a great many conventions. I know that many of them in point of numbers have been greater than this one; but I feel safe in saying that you have never before entertained any convention that was so fraught with possibilities for the development of our State, and so broad in its scope of usefulness as is this little assemblage that you have with you today. We come to you with a key which will unlock a storehouse of wealth in North Carolina as broad as man's conception and as deep as the limit of human endeavor. We offer the solution of a problem which has vexed our farmers in this State since its earliest history. We suggest a method of controlling our rains so that they will be showers of blessings indeed. Have you ever thought what a great power water exercises over the prosperity and development of our State? Every year thousands of pilgrims come within our borders to gaze upon the majestic ocean and to bathe and fish in its waters, and to sail upon its restless bosom. These pilgrims are come to see, but many of them pass the winter and remain to enjoy the blessings of health, climate, soil, and beauty with which the God of nature has so wonderfully endowed us. Countless other thousands of men fish in our inland sounds and rivers, earning a livelihood for themselves and supplying our tables with delicacies that would tempt the very gods. Our inland waterway, when built, will link the northern markets with the calm southern sea, and in the event of either war or peace will furnish a channel through which boats of light draft will pass in perfect safety; while ocean, canal, rivers and sounds combine to furnish an avenue for a commerce which is fast making our coast cities rich and powerful. From out of the heart of our western mountains tiny springs start on their eastern journey, bearing with them the rugged strength which they have inherited from the hills which gave them birth. Stronger and stronger these streams become until by the time they reach Piedmont North Carolina it is but the sport of a mighty giant for them to turn the wheels which run your mighty mills, furnishing light and heat to your cities and blessing your surrounding country. It is a fact that these streams, after gathering the latent power of the west, have laid it at your feet. Small wonder, then, that your country has blossomed like a rose, and that your cities have become rich and powerful. These streams have continued their eastern journey, and they have beautified and blessed the country through which they passed until they reached our east, and then they paused for a rest before they reached the sea, and, instead of becoming a blessing, they became a curse to our land. We in the east have been somewhat like the man who fell over shipboard. He was telling his friend about it afterward, and said as soon as he reached the water a shark grabbed him by the

foot; and his friend asked him what he did then. He said why he gave him the foot; he didn't stop to argue with the shark. Now, we of the east have stood idly by for centuries and permitted these waters to monopolize lands which are immensely rich, and we never argued the point with them. But in September, 1908, a little band of men met together in New Bern, North Carolina, and organized our State Drainage Association. The purpose of this Association was to promote the drainage of wet and overflowed lands, and to deny the right of these rivers to bless all other sections of the State and then curse our lands with such an excess of water as to make them of little agricultural value. Great as was the vision of these men, heroic as their courage, I have no idea any of them even dreamed of accomplishing in so short a time the results that they have attained. Only eight years have passed since that time, and under the auspices of this Drainage Association our east has blossomed into a land of sleeping opportunity. From out of this wild wilderness we have hewn for ourselves a very Garden of Eden, a garden where slight endeavor yields abundant reward and honest and steady toil yields more than a just recompense.

I am glad, gentlemen, that I have some living witnesses present this morning when I talk about our swamp lands, for I know if you have heard them talk about the wonderful richness of this land, you would want some one to justify the stories. A Yankee once was talking to an Englishman. He said he had killed 999 snipe in one day, and when asked by the Englishman why he did not kill 1,000, he said he thought he had done enough, and would not tell a lie for one snipe. The Englishman said he knew a man who swam from Liverpool to Boston. The Yankee said: "Did you see that man swim from Liverpool to Boston?" The Englishman said, "Yes." The Yankee said, "Yes, you are right there, old man; I am the man who did it, and I have been looking for a living witness to it ever since." I am glad to say that we have living witnesses who are willing to second any statement that we may make about that swamp land down there, and the limit of these witnesses is only measured by the number of people who have seen it. I have not the information at hand which would enable me to tell you just how many acres have been developed, but I know there are many thousands of acres which have felt its influence, and I know in Hyde County there is a great lake, the bottom of which, containing many thousands of acres of land, has been made fit for the habitation of man. I know that in my own community we have something like 125 miles of canals cut by dredges, and they furnish an outlet for something like 125,000 acres of land. We have now three immense dredges, toiling day and night in order that other thousands of acres may be drained and developed. We have just within a few miles of my home 7,000 acres of corn growing on land that a few years ago was only covered with water and forest growth. This land this year has produced from 40 to 45 barrels of corn to the acre, so that we can say that this one piece of land alone, which ten years ago was valued at 50 cents per acre on the tax books, has produced in one year 350,000 bushels of corn. In cutting down and clearing for a new land, we are working an army of men large enough, if trained, to take the city of Greensboro every day, and we have only just begun the gigantic task which lies before us. We have been so successful in the drainage of swamp lands that we have added another phase to our drainage work. It has become more and more apparent that if the fields of North Carolina are to produce their best,

we must establish a system of underdrainage; so that the North Carolina Drainage Association has undertaken this work also, and this interests every section of the State.

Last year at Belhaven we elected a Vice-President whose duty it was to take charge of this particular phase of the work, and knowing him as I do, I feel sure that this Convention will be both entertained and instructed by his Department, and we will hear from him in the proper time.

Now, in view of all that we have accomplished in these eight years, we cannot help but feel proud of our Drainage Association and proud of the law for which it was responsible; but it is with regret that I am compelled to state that dissension has arisen in a great many of the districts that we have established, and frankness compels me to say to you that in a measure this dissension is justified. There are a number of reasons for this, one of which is that these drainage districts are composed of a large number of small estates, all of which have been operated by their owners and drained according to their own peculiar ideas and whims, and it cannot be expected that all these men will agree to surrender the rights and privileges which they have heretofore enjoyed into the hands of two or three men, whom some of them are unwilling to admit are more competent than themselves.

Another trouble is that, unfortunately, we have sometimes, in some districts, secured commissioners and viewers who were not fully competent, and being new and untrained, these commissioners or viewers have made mistakes, and costly mistakes, insomuch as that in a few instances the very life of the district has been jeopardized. Now, these two conditions can be corrected; but the third is perhaps the most vital trouble which we have encountered, and that is that our law, being new, has proved not to be sufficiently elastic to meet the needs which actual experience has emphasized in the field, and it is this problem, the amending of this law, which confronts this Convention today. I shall not enter into a detailed discussion of the changes that I think should be made at this time; because if I do, I would talk so long I am afraid you would do me like a little boy down in my section once did. There was an old gentleman who lived out a few miles from my town, who visited the Sunday school very often. When he came he always began to talk to the Sunday school class, and he would begin by saying, "Well, children, I hardly know what to say this morning," and then would start in and talk about an hour. There was one little boy in the class who lisped, and when the old man began with his usual words, the little boy rose in his seat and said: "For goodneth thake, thay amen and thet down." I will say that we cannot any longer delay the amendment of this law if we expect the confidence of the individuals who live in these various drainage districts, and I trust that all of you have already studied this problem and that in the proper time we will have suggestions, and that out of these suggestions we will devise a law that will meet the needs of the occasion. I thank you.

REPORT OF THE SECRETARY

The Eighth Annual Convention of the North Carolina Drainage Association was held at Belhaven, Beaufort County, North Carolina, November 29 and 30 and December 1, 1915. The meetings were held in the City Hall of Belhaven, and were presided over by the Secretary, Joseph Hyde Pratt, and Vice-President P. H. Johnson, in the absence of the President, Mr. Lawrence Brett.

Since the organization of this Association eight years ago there has not been held a more enthusiastic and interesting Convention than the one held at Belhaven. Twenty-one counties were represented, as follows: Beaufort, Bertie, Carteret, Craven, Currituck, Edgecombe, Guilford, Hertford, Hyde, Lenoir, Mecklenburg, New Hanover, Orange, Pasquotank, Pitt, Robeson, Tyrrell, Wake, Washington, Wayne, and Wilson. There were also representatives from the District of Columbia, Missouri, Ohio, and Virginia. There were 116 registered delegates, 102 of whom were outside of Belhaven. Representatives of various dredging and contracting companies, banks interested in the purchase of drainage bonds, and companies producing tile were present. The Drainage Law was thoroughly discussed, not only by the delegates, but by the bond dealers and contractors, and it is believed that some important points were brought out which will undoubtedly result in the solution of many points of the Drainage Law which have not proven entirely satisfactory.

The officers who were elected for the coming year are: President, P. H. Johnson of Pantego; Secretary-Treasurer, Joseph Hyde Pratt of Chapel Hill; First Vice-Presidents, M. W. Thompson of Greensboro (in charge of District Drainage), Prof. M. E. Sherwin of West Raleigh (in charge of Tile Drainage); Second Vice-Presidents, one from each county represented.

The delegates were taken to visit Lake Mattamuskeet District in Hyde County, on a boat from Belhaven to Swanquarter. The people of Swanquarter and Belhaven provided automobiles for taking the delegates to Lake Mattamuskeet, where they were delightfully entertained at an oyster roast, etc.

The following towns sent invitations for the 1916 Convention: Raleigh, Greensboro, Goldsboro, Charlotte, Creswell, and Lumberton. Advocates for each city presented very strongly the advantages of holding the next Annual Convention in their city, and after considerable debate Greensboro was selected as the next meeting place.

A full report of the proceedings of the Convention has been prepared and the manuscript is now in the hands of the printer, but we were unable to get it ready for distribution before the opening of this Convention.

REPORT OF TREASURER

The Treasurer's report for the year November, 1915, to November, 1916, was read and referred to an Auditing Committee consisting of Messrs E. E. Hunter, W. H. Bullard, and C. A. Statesbury, who reported as follows:

We, the undersigned committee, have audited the inclosed vouchers, and find them to be O. K. with the exception that bill for stenographic services, \$20, dated December 3, 1915, has not been receipted.

APPOINTMENT OF COMMITTEES

The President appointed the following committees:

COMMITTEE ON RESOLUTIONS

John H. Small, <i>Chairman</i>	Beaufort County
Bennehan Cameron	Durham County

W. C. Boren.....	Guilford County
E. Williamson	Sampson County
W. F. Aberley.....	Craven County
John Wilkinson	Beaufort County
N. L. Cranford.....	Forsyth County
A. E. Hire	Forsyth County
G. B. Sellers	Robeson County
James Slate	Stokes County
Bruce Craven	Randolph County

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

W. D. Alexander, <i>Chairman</i>	Mecklenburg County
V. T. Baggett	Sampson County
J. L. Becton	New Hanover County
M. W. Thompson	Guilford County
D. B. McNeil	Robeson County
J. Slate	Stokes County
Bruce Craven	Randolph County
C. A. Statesbury	Hyde County
J. B. Blades	Craven County
C. H. Jessup	Stokes County
Lovit Hines	Lenoir County

MEMBERSHIP COMMITTEE

Miss H. M. Berry, <i>Chairman</i>	Orange County
E. Williamson	Sampson County
John D. Waldrop.....	Guilford County
C. Bodenheimer	Stokes County

AUDITING COMMITTEE

E. E. Hunter, <i>Chairman</i>	New Hanover County
W. B. Stafford.....	Forsyth County
W. H. Bullard.....	Sampson County

COMMITTEE FOR JUDGING TILE DRAINAGE REPORTS

Prof. M. E. Sherwin, <i>Chairman</i>	Wake County
H. M. Lynde.....	Wake County
F. R. Baker.....	Wake County
H. Cowley	Edgecombe County
T. E. Brown	Wake County

LEGISLATIVE COMMITTEE

John H. Small, <i>Chairman</i>	Beaufort County
A. Wayland Cook	Guilford County
Bruce Craven	Randolph County
Lawrence Brett	Wilson County
P. H. Johnson	Beaufort County

FINANCING OF DRAINAGE IN RELATION TO FEDERAL FARM LOAN BANKS

By PROF. WILLIAM R. CAMP of the North Carolina Experiment Station and Extension Service

Mr. Chairman and Gentlemen of the Convention: The subject I have to talk to you about is one that is very vital to the development of the agriculture of this State, and especially vital to you men in your profession as drainage engineers. No law has been passed by Congress that has meant more to the development of the agriculture of the United States than the Federal Farm Loan Act, and after the farmer, there is no body of men who ought to be more interested in this act, to know its provisions and to help farmers to make use of them, than you drainage engineers. Frequently your projects are held up for lack of the finances to carry them forward. As I understand it, you have in this State a special law providing for the financing of drainage propositions, but so far it has not been possible to exempt the bonds from taxation. The law we are to consider has an advantage over the North Carolina law in that the bonds issued will be exempt from taxation. I shall take it for granted that you do not know especially about the new Federal Farm Loan Act, except perhaps in a general way, and some may not know that. We will endeavor briefly to state what it offers to farmers. A similar law for long-time credit has been in operation in Germany and in European countries for over a hundred years, allowing German farmers to get their money at a low rate of interest, something like $3\frac{1}{2}$ per cent to $5\frac{1}{2}$ per cent, while the American farmer has paid so far for his interest on his loan something like $8\frac{1}{2}$ per cent on an average.

We have banking institutions in this State in plenty, perhaps too many; but I am going to tell a story of what a banker told me to show the inability of the banks to make long-time loans for the development of agriculture. A friend of his came to borrow \$6,000 on a piece of land which he wished to purchase. The banker told him: "I cannot lend you that money." His friend said: "Come around and look at the land, anyway." The banker went around and looked at it, and said: "Why, the timber alone on this land is worth \$6,500! Yes, I will lend you the money." This man wanted the loan in the first place for agricultural purposes, and for that purpose he could not borrow the money from the bank; but the fact that there was \$6,500 worth of timber on the land made the banker look at it in a different light. This shows that bankers are ready to make loans for short-time purposes for business development, but for agricultural development over a long time they are not willing, because they have to lend primarily demand deposits; that is, they have to lend primarily not their own capital, but the money which depositors have put in the bank, and which they may wish to draw out at any time. Banks cannot afford to lend these deposits over a long period of time. As a result of this situation, we have a great agricultural State awaiting capital for its development. Men that have spare money would buy land, but the banks have no money to lend for its long-time development, and at most can only lend it for a year, with privilege of renewal. While the land in farms for the total area forms 46.2 per cent for the United States and 71.9 for North Carolina, still the per cent of land in farms which is improved is 54.4 per cent for the United States and only 39.3 per cent for North Carolina. These figures show that a large per cent of our land is in farms, but a small per cent of the

land in farms is under actual cultivation—in fact, the smallest per cent for any State in the South Atlantic States excepting Florida.

Now, briefly, just how is the new Federal Farm Loan Act to bring in new capital? In the first place, the law provides for the establishment of a Federal Farm Loan Board appointed by the President. This Board is to divide the United States into twelve Land Bank districts. Each district is to have a loan bank, and in order to have a loan bank there has to be a capital of \$750,000. This capital is either to be subscribed by farmers or by the Government. If the farmers do not subscribe the whole amount, the Government has to subscribe the capital, so that it can insure that the bank will be started, and these Land Banks, twelve of them in the United States, can lend money up to twenty times the value of their capital, or \$15,000,000 for each Land Bank district. Fifteen million dollars will be the minimum that a Land Bank can lend as soon as the farmers own all the stock.

How is the farmer to take hold, how is he to come in? In order for the farmer to borrow money, he not only has to furnish proper security, but he has to become a member of a National Farm Loan Association, and there have to be at least ten members, and they have to borrow at least \$20,000. When you have an association of borrowers like this, they may apply for a charter from a Federal Land Bank. To have an application favorably considered, the security of the land has to be twice the value of the loan the farmer wants to secure. If he wants to borrow \$1,000, his security must be land worth \$2,000. The value of a piece of land should be based largely upon its earning capacity. Improvements do not count unless they are insured, and then loans may be also made upon one-fifth of the insured value of the improvements. Now, this applicant for \$1,000 cannot use it for speculative purposes, so that you might say that in so far as your drainage propositions are speculative, just that far the Federal Farm Loan Act will not help you at all; but in so far as your drainage projects are promoted by farmers who want to borrow for the development of farming, for the purchase of land which the owner wishes to improve and farm, or for paying off an already existing mortgage on the land, then the money can be secured under this act.

The interest rate cannot be more than 6 per cent. The farmer can have any length of time from five to forty years to pay his debt in. To illustrate: if a farmer wishes to borrow \$1,000 and use part of it to pay his pro rata share of drainage expenses for his district and his share for the clearing and drainage of his own particular piece of land, or for its tiling, he could borrow the \$1,000 for twenty years by forming an association of ten borrowers. If the rate of interest is 5 per cent, the payment upon interest and principal would amount to \$80.24 for each year. You see that this is only about 8 per cent for the payment of the interest and reduction of the principal. If the borrower makes his loan for a longer time than twenty years, the payment upon the principal would be less. After five years, if the farmer has done so well that he desires to pay the whole amount up, he would be free to do so in any amount which is a multiple of \$25. In brief, the advantage of the law from the farmers' point of view is: a low rate of interest and easy terms of payment. There need be no fear of foreclosure. The farmer can go ahead and develop his land and gradually pay for his land or improvements out of his earnings.

To explain the organization of a National Farm Loan Association, let us assume that we have here ten farmers who want to borrow on an average

\$2,000 apiece or \$20,000 altogether. Their mortgages covering the loan must be worth at least \$40,000. To borrow this amount each of the farmers has to join a National Farm Loan Association and make application for a charter to the Land Bank of the district. The Division of Markets and Rural Organization of the North Carolina Extension Service, West Raleigh, N. C., is coöperating with the Federal Farm Loan Board to help farmers organize free of charge. This Division has furnished organizers to show the advantages of the law and to help farmers take the first steps toward forming a National Farm Loan Association. If the application for the association just assumed is approved, bonds are issued on the mortgages of the individual farmers.

Each farm loan association has to sign the note of the individual farmer, so that it becomes responsible for the payments of each individual farmer's loan. Now, to assume that responsibility the National Farm Loan Association has to have a loan committee of three men, who pass on each application for a loan, to see that the security is sufficient. To back up this loan and really make this committee do its duty, each borrower has to take 5 per cent of the value of his loan in stock. For instance, if he wanted to borrow \$1,000, he would take \$50 in stock in his local association. While the farm represents a security to the loan, yet you might say this arrangement makes each member of the loan committee interested in doing his duty. Each member of the loan committee is a borrower, and as such he is liable for any defaults to the extent of 10 per cent of his own individual loan. The question arises as to how far members would be liable under the worst circumstances. Under the European law loan associations sometimes have unlimited liability, and they find it does not work harm, because it really adds to the assets that form the security for borrowing. They say it really increases the borrowing power and lowers the rate of interest, so that instead of in reality adding to the risk of the individual borrower, it lowers his rate of interest. In this country we had an idea that American farmers would not stand for unlimited liability, and so we have limited the liability of each borrower to 10 per cent of the value of his loan, or once over the value of his stock. It is the same liability that you would have if you should buy stock in a National bank: you would be liable for your stock and once over. If you take stock in the farm loan association, you are liable for your stock and once over. Another interesting point is that no farmer has to put his hand in his pocket to invest in stock. He can take part of the money he borrows and pay for that stock. The stock is an investment which draws interest, but which must cease when the farmer ceases to be a borrower. The stock forms part of the last payment on the loan. Thus the security for the repayment of loans is of two kinds: (1) the mortgage of the borrower and (2) the stock owned by the borrower. The stock form of security makes all members, whether of the loan committee or not, interested in a conservative valuation of each farm and also in seeing that the money borrowed is used for the purposes specified in the loan contract, that is, for purposes which shall enhance the value of the security offered by each member.

In addition to the appraisal by the loan committee of the local National Farm Loan Association the Land Bank sends out an appraiser to value the land. If on appraisal the applications are all granted, or if some of them are cut down, and you have still \$20,000 applied for, your charter will be granted, and then the mortgages of this association and other associations

are entrusted to the Land Bank Registrar, and the Land Bank, upon the approval of the Federal Farm Loan Board, issues bonds upon these securities for not less than \$50,000 at a time.

This whole system is rather a complicated one, but there are only a few things that the farmer has to understand. First, you have the appraisal of the local committee, and this appraisal is submitted to an appraiser of the Federal Land Bank. Moreover, every Land Bank is liable for the payment of the bonds to the extent of the pro rata share of its own borrowings. That is, it could not be required to pay all the failure of one Land Bank, but all the Land Banks in the United States would have to pay their share of the failure of one Land Bank. With all this machinery to guarantee that the security for bonds shall be sufficient, the security of the individual farmer is established, so that it can have currency at any place in the United States. Thus Tom Jones down in Duplin County may desire to borrow money. A lender in Massachusetts, Illinois, or California need know nothing about Tom Jones or his earnings, whether he is shiftless or thrifty. The Federal Farm Loan Board takes all this worry off from the lender so he can sleep on his bonds and be content to lend at a low rate of interest, because his security is safe beyond question. The Federal Farm Loan Board provides all the machinery of inspection to guarantee the security of all loans. The Federal Farm Loan bonds, like Government bonds, are free from all taxes, either Federal, State or municipal. Not only that, but these bonds are considered as legal investment for trust funds, and proper security for public deposits and appropriate investment for the Federal Reserve Banks. Thus the Government has established them on the very highest basis, and their sale is going to be different from the sale of your drainage district bonds, because they have the security not only of that local district, but of all the districts in the United States. This combined security makes the loan gilt-edged, so that the investor may sleep overnight and give no thought to the security that is going to make this bond one of the most attractive investments to every one in and out of the State. For instance, if you have \$25 you want to loan, or \$50, or \$500, or \$1,000, you can buy these bonds, and while you cannot hope to get more than 5 per cent, yet that 5 per cent would be net. There would be no tax on it, so that this is going to be an attractive form of saving and permanent investment. The States of Massachusetts, New York, and Connecticut alone have two billion and a half dollars in savings, and the bonds of the Federal Land Bank will give the lenders in these States a most conservative form of investment.

One other advantage that I would like to mention: One of the greatest of all weaknesses of American farmers is their unwillingness to coöperate; it is every man for himself. Take the American farmer individually, and there is no better or more intelligent group of men in the world than they; but when it comes to coöperative action, team work, working together with one another, doing a thing together which may be of common interest to all, but which the individual farmer is helpless to do alone, there is no weaker group of men in the whole world than the farmers. Europe has been learning for years the value of coöperation. The majority of the farmers in this country have not. This law will have for one of its main effects the establishment of coöperation among the farmers. It will reduce the cost of appraisal, reduce the cost of legal fees, help to introduce the Torrens system, help them to feel

mutually responsible in their own appraisal, and help to do away with some of the suspicion which has developed in the American farmer as a result of his isolation. Thus one of the best results of this law will be the development of a spirit of coöperation, whether in the establishment of a drainage district, or helping the farmers to market their products, or to come together for any social or economic advantage

MR. JOHNSON: I am sure we are very grateful to Professor Camp for the very instructive and interesting talk he has given us, and he has kindly suggested that we might be permitted to ask some questions:

QUESTION: You referred to Tom Jones just now. I wondered what would happen to Tom Jones if he sells that land while the mortgage is outstanding?

ANSWER: It would be the same as any other mortgage. The obligation would be passed over to the person who buys the land; he would be released.

QUESTION: What governs as to whether the interest shall be 6 per cent or a lower rate?

ANSWER: It will depend upon the sale of the bonds. That is one reason I gave so much time to the system that has been developed to make these bonds gilt-edged. If the public will only see it, behind each bond is not only the collateral put up, but it has been appraised by the Land Bank district appraiser; and not only the Land Bank is liable, but all the Land Banks are liable for the payment of the bond. The farmer will not have to pay more than 1 per cent over the price the bonds sell for. If the bonds sell for 5 per cent, a farmer will have to pay 6 per cent.

QUESTION: You estimate that 1 per cent will pay the cost?

ANSWER: The cost is limited to that.

QUESTION: How is that 1 per cent returned to you?

ANSWER: The rule is that the rate of interest shall be only 1 per cent more than the latest bond issue.

QUESTION: The initial borrower pays 6 per cent; later it may bring 5 per cent.

ANSWER: At the end of five years he can change from one issue of bonds to another, and get the advantage of a lower rate of interest.

QUESTION: Under existing conditions, if I borrow \$1,000 and give a mortgage on land, then I sell it afterward, the only way I can be released is to have that mortgage cancelled and a new mortgage issued. In this event, if I borrow some money for, say twenty years, the only thing I can see would be to pay the whole thing off when I sell. In that event, if I sell the land within five years, what shall I do about the mortgage?

ANSWER: The application would be passed over to the man to whom you sell.

QUESTION: Would it be possible to make a loan on these swamp lands? Would that be considered good collateral for a loan?

ANSWER: That will be one of the difficult problems of appraisal. It has not an earning capacity as yet.

QUESTION: If they wanted to raise money to put through a drainage project, would they be able to do that through a Land Bank?

ANSWER: I think they would, although I do not know just what would be the policy of the Board. I wrote up to the Federal Board to get some ideas as to what their policy would be in regard to drainage projects, but have not received an answer.

QUESTION: Did I understand you to say that where a drainage district had already been organized and bonds issued against this property, it would be impossible to borrow money from these banks on this property until after these bonds are paid?

ANSWER: The Government allows no loaning of money on second mortgages. That mortgage would have to be taken up with part of the money borrowed.

QUESTION: Suppose one of these ten men should default in his payment, would the other nine be responsible?

ANSWER: If a man defaults in one payment, or if he defaults on his loan, the balance who go into the Association would be responsible, but they could foreclose that man's mortgage for their protection. That makes it necessary for your Loan Committee to see that the collateral is there. I might say a word, in passing, as to how you men might help farmers get started. Sometimes it is hard to get a bunch of farmers to act together, and so we have got out individual application blanks for a loan. Already there are over sixty Associations which have been formed, and a good many have been formed by the farmers themselves. This has all been done since the first of September. The loans applied for amount to over three million dollars.

MR. SMALL: This discussion has brought up a very interesting phase of our Drainage Law. Now, the present law provides that a district is established and the share of each landowner is fixed; he may pay in cash the amount of his assessment, which would be a saving to him; otherwise the proportion that has been fixed against his land as the cost of drainage is divided into ten annual installments, the first installment on the principal not being due until three years after the district is established; but there is no provision under the law at present by which a man who elects to pay his proportion of the drainage liability, or by which he may pay up in one lump sum; so that in view of the possible

application by many landowners for loans under the Federal Farm Loan Act, they will be confronted by the difficulty that here is a first liability on their land running over a series of years. If they have paid one installment on this liability, it will not be possible for them to take up the balance until the whole series runs out. This loan must be a first lien on the land that might prevent him from borrowing from this Federal Loan Bank, and there would be no method under our present law by which he might pay in advance, except, of course, by paying the balance he owes, plus 6 per cent interest for every year over which the drainage bond should extend; so that it is well to consider an amendment to our drainage law by which a man can pay up what is due, plus some slight sum as a compensation for his withdrawal from the payment of interest, so that he can take advantage of the Federal Farm Loan Bank. I just suggest that because it is pertinent right here.

DRAINAGE IN THE PIEDMONT SECTION

By W. D. ALEXANDER, Drainage Engineer

Along the water-courses of the Piedmont section are bottom-lands of varying widths. Upon these lands the early settlers and their descendants depended for their corn crops. As the hills have been cleared and allowed to wash away, the crooked channel of the stream began to give trouble. This gradually filled up and became more subject to overflows. The chance of harvesting a corn crop became less each year, until about forty years ago, when the owners began to abandon their bottoms. Many of the farmers tried to straighten the channels and cut new hand ditches for the streams. This answered for only a few years, because not enough of the farmers acted together and the ditched stream was not long enough to protect itself; rafts, logs, etc., were allowed to collect and soon caused the ditches to fill up. Furthermore, ditching was so expensive that it was discontinued.

The first drainage district was organized in this section about seven years ago. The commissioners bought a dredge and employed operators and did the work themselves. The farmers of this district have harvested six very fine crops of corn from their bottoms. Immediately following this district were others, until now there are more than forty of these districts that were in swamp now raising crops of corn. There are about fifty thousand acres of this land that can be classed as reclaimed land—absolutely worthless before dredging, even a menace to the health of their communities, as they were breeding places for malaria and mosquitoes. These bottom-lands are extremely fertile, being built up with the washings from the hillsides; they produce very large crops of corn. The reclaimed lands of Piedmont North Carolina produce annually over two million bushels of corn. In addition to this, the health of the community is largely improved. Some drainage enthusiasts claim the saving in doctors' and medicine bills are enough to pay for the drainage.

The average cost per acre of reclaiming land in this section is, for the draining, from \$15 to \$30 per acre. This land, when put into cultivation, will sell for \$100 an acre.

In talking dredging to interested parties, their first question is, "Will it last or will it fill up in a few years, as the streams did in the past?" I answer that this way: I know ditches that have been standing for five years that are in better condition today than when they were dug. I also have seen some that were allowed to go to pieces in a very short time. It is impossible for man to make anything that does not need attention, and a ditch is not an exception to this rule. These swift-flowing streams have a tendency to bring down large quantities of sand; as much as possible of this sand should be kept out of the ditch and the ditch should be so designed as to carry away the sand that is brought to it.

The engineers who first began drainage in this section made the dredged channel follow the old water-course except to make some few cut-offs. They later tried the swamp style of ditch, or what is called the "Paper Survey," which is to make a survey of the bottom-lands and map it. On this map mark out the proposed ditch as straight as possible; then locate this ditch line on the ground. It has now been found better for the engineer to stake out the ditch on the ground, paying especial attention to the kind of soil he is crossing, avoiding deep sand banks and rock ledges, giving due consideration to the old channel, a straight channel, and the general location of the new channel.

There is a general belief among districts that experienced engineers and contractors are a needless expense. They think a county surveyor can run around the bottom-land and ascertain how many acres of land are in the district. Then the commissioners can buy a second-hand dredge that some neighboring district has used, employ a dredge runner, and have the job dug for half what it would cost if they had employed a drainage engineer to properly lay out the desired improvements and let the work out to a competent contractor. I agree with these people that they can have the work done this way cheaper; but what kind of a ditch will they have? They will have a ditch that is improperly located and designed, no berm, dug with a machine that is not suitable for that size ditch; the banks will cave and the entire work will be unsatisfactory. Before two crops of corn have been planted all of the property owners are mad at the drainage commissioners who, by false economy, saved them half the expense of ditching. It is possible for the district to buy a dredge and do the job themselves if they have a first-class drainage engineer to visit the work every week and will do what he says.

Following are some of the advantages of having a competent drainage engineer on the work: He is of service in the preliminary survey, being able to tell whether the work should proceed or be abandoned. His greatest value is in the survey and final report; under no conditions should a district be dredged unless it has been properly staked out. In the letting of the contract he will save the price of his services, as contractors will bid closer if they know what is to be required of them. Bond buyers want a district in the hands of a drainage engineer, if they are to handle the bonds. The contract is not completed and the contractor should not be released until the work is passed upon by an engineer, as many defects will escape notice unless they are looked after by an engineer.

Drainage has just started in this section; every stream needs it; and whenever a district is properly drained it is a source of inspiration for all of the landowners in a radius of 25 miles to organize their swamps into districts. However, if a district is not properly ditched and the work is unsatisfactory

to the landowners, who have profited by the first cost, it is a hindrance to all work in that section of the State.

Let us all who are interested in drainage see that the work is efficiently if not so economically done. Let us impress upon the commissioners that they must have a maintenance fund or else trespassers will cut footlogs. These will collect rafts which will soon be islands and fill up the once beautiful canal.

PIEDMONT DRAINAGE

MR. N. L. CRANFORD of Forsyth:

Mr. Chairman, Ladies and Gentlemen: A few days ago I received a program from Dr. Pratt, and noticed my name on it. I had written Dr. Pratt that I was unable to talk in public, and that we had not actually accomplished anything in the drainage line in Forsyth County. We have been trying to organize a drainage district in Forsyth County for three years. I have gotten into the Superior Court twice, and out, and am now back again. When I first took up this project there was not half a dozen men in Forsyth County who ever saw a dredge. I took the project up with Mr. Prince, and we tried to interest the farmers in it, and took a bunch of them to Iredell County, trying to convince them that drainage was a good thing. The trouble was we could not get the opposition to go. I do not know when I will get a district organized. We have some valuable land in Forsyth County which, if drained, would be a great deal more valuable, and we hope in the course of time to get a district organized over a distance of about 24 miles. We had Mr. Alexander go over this district, and also Mr. Lynde, and talk to the farmers. I hope this Convention will tell us how to organize that county. We presented our petition nearly three years ago. We took the proceedings through the court, before the clerk, then took an appeal once to the Superior Court, which was sent up to a referee. We had 110 petitioners, with 85 appellant defendants. A few days ago it came up again. The clerk of the court found that we had a majority, and ordered a survey. They appealed from that, and it is back now in the Superior Court again.

MR. ALEXANDER: One of the principal things they appealed on is in our preliminary report we did not show how far the ditch would go on the tributaries. The lawyers contend that we should have gone on up those streams six or seven miles. To bring these in, we would not have a majority on the petition. It is usually customary in the Piedmont section with our preliminary report to make a very preliminary map. We just use a Government soil map, or something like that, and in this instance we used a map made by Mr. Lynde, and we only showed on that map where the drainage would begin and where end. We were supposed to go as far as high water would strike, but did not show how far up on the branches.

MR. JOHNSON: I want to say that I am exceedingly glad to have Mr. Cranford here today and to have heard what he has said. There is one thing about this North Carolina Drainage Law and that is that in the end

it will surely organize a drainage district if it is a feasible proposition. It may take a little time, but we are able, as a rule, to show the people. The strongest point in our law lies in the fact that if you have a majority of the petitioners or ownership of land, you can force individuals in, whether they want to come in or not, and the only trouble I have seen has been in the fact that people in starting these new districts do not always conform with the exact letter of the law, and in a number of instances it has been necessary to go back and start again. If you will comply with the law, I am not afraid but what you will get a drainage district. I know of a big drainage district that was held up because it was a piece of property belonging to a number of individuals, and notice was served on only one of them. These little technicalities can delay the proceedings. If you look after the legal end, there is law enough to bring them in. In our district we had a strong corporation to fight all the way through, and we afterward came to a compromise with them.

REPORTS ON DRAINAGE DISTRICTS

MR. P. H. JOHNSON:

Broad Creek Drainage District.—The work on this district is practically completed. We lack something like half a mile now of all the ditches being cut. A great many of these ditches have been gone over for the second time. There is now between five and six thousand acres of new land to plant to corn this year, and there will probably be a larger amount cut down during this spring and planted next year; so that I believe we will have at least twelve thousand acres planted in corn next year.

Conaby Creek Drainage District.—This has never amounted to anything.

Jackson Swamp Drainage District.—In this district the work is about completed. It is a small district, but it has opened up some very valuable land. It was largely established to furnish an outlet from lands already cleared. The swamp in this was not so dense, but the soil is good for general purposes.

Pantego Drainage District.—This was the first to be organized in the State and the first to begin actual work. We have had our work practically completed now for about four or five years. Our bonds are about six years old; we have paid interest three years, and have seven years more to complete the payments. I reckon that district has had a more varied experience than any other district in the whole State. We had peculiar conditions. We came into a town and took in part of it. We cut canals, one of which was eleven miles and the other thirteen miles. We drained about 16,000 acres of land, and the 11-mile ditch is an outlet and the 13-mile ditch is an intersecting canal that was designed to drain the water from something like 60,000 acres of land above us from overflowing our land after we had provided an outlet. I am sure the land in that district, taken as a whole, has increased in value over 400 per cent. I know that is a conservative estimate. There is not in that district an acre of cleared land that could be bought for less than \$100. There is not an acre in the woods that can be bought for less than \$30, and I can easily remember when that land was valued for taxation at 50 cents per acre, and

we had not more than half of the exact acreage on the tax books. If you people, those of you who have never been into eastern Carolina, would come down there and look at Pantego and Broad Creek Drainage districts, and see the wonderful results that have been accomplished there, if Mr. Cranford could get his people to look one time at these results, I would guarantee that he would hardly have a dissenting vote when it came to the establishment of his district.

I was out in Ohio once, and we had some samples of soil out there. We had a miniature pasture showing cotton growing in this soil. There was a man who came to me and called me off privately and told me that of course he recognized the fact that we had a good exhibit there, and he felt proud of it as being in the United States. He had never seen anything as good as that, taken as a whole. He said: "Of course, I know that samples of this came out of some rich spot in a garden or some place that has been specially fertilized." I said: "If you will come to my town, I will take you out in the country, and if I do not show you thousands of acres of land just like this, if I do not show you crops just like the crops we are exhibiting here, I will pay all your expenses down there and back." Two weeks after that he came to Belhaven and I showed him the soil and the crops about on the land. I asked him, "Now who pays expenses?" He said, "I will have to pay my own expenses." That man went back home and returned to Belhaven and bought 600 acres of land in that vicinity. We made some mistakes in establishing our district, and it cost us more money than perhaps it ought to have cost us; but I am sure—and when I speak for myself, I speak for all other districts—that drainage is worth four times what it cost; and as I said this morning, when we have cleared and drained all these swamp lands (and we are going to do it) we will make North Carolina the greatest agricultural State in the Union. I have studied farming conditions all over this country, I have knocked about a good deal, and wherever I have gone I have made it a point to look at the land and the crops, and I have seen places where they can grow as much corn or as many potatoes to the acre as we can. I have seen places where they can grow as much cotton to the acre as we can, but I have never seen any place anywhere in any State where the same acre of land will produce as large a yield of all these various crops as well as North Carolina. And this is a big problem that we have before us. I cannot too strongly emphasize the necessity of so revising our drainage law that it will meet the exigencies of the occasion. I have been a member of three different legislative committees, and we have spent a great deal of time considering this law. Mr. Small and Dr. Pratt have spent weeks studying the law and the revisal of it, but the question that came up this morning has never been raised before. We must have these amendments right now, and I hope you will favor us with any ideas you may have formed during the next session of the Convention.

Pantego River is also in Beaufort County, and I will say that work is practically complete, and the conditions are just about the same as the others, except that there is more land developed. The land is being developed very rapidly in the Wenona section.

In regard to the old rice lands, would say that ten years ago we had bought a farm that was killed entirely by rice twenty years before that time. We could not get it to produce anything. This land grew broomstraw and nothing else for twenty years, and was not cultivated. We bought that farm and

thoroughly ditched it and limed it, and Mr. Kerr in Raleigh was kind enough to say to us that we had the nicest farm in the State now. That land has been cleared now about ten years, and yesterday I was picking 120 bushels to the acre of Irish potatoes in that field. This spring we had a similar yield. We usually make ten barrels of corn to the acre and push a bale of cotton.

J. L. BECTON :

New Hanover Drainage District No. 1.—This has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars.

New Hanover Drainage District No. 2.—On this the preliminary report has been prepared and handed in, and we are now ready for a final report. The same is true of New Hanover District, No. 3.

Little Coharie Drainage District, Sampson County.—This was the first district to be tried in our county of Sampson. We had had no experience. We went ahead without the assistance of an expert attorney. We did not follow the letter of the law, you know; our clerk of the court was not a lawyer and did not realize the necessity of following every detail. We thought everybody in the county would surely be in favor of drainage, and did not summons to court everybody connected with the district. We did not notice that ourselves, and when the report was filed our opponents had a notary and stopped us. The clerk of the court was going to give us another meeting, but we stopped right then. Before we made arrangements to go on with the proceedings, the petitioners filed an injunction for the bill of costs. We have never made a start since.

MR. JOHNSON: I want to say you have mentioned a thing that is vital in the establishment of a district. The first thing to do is to employ the very best attorney available, and the next thing to do is to employ the best engineer available.

Brown Creek Drainage District of Anson County.—Never organized.

Cabarrus Drainage Districts, Nos. 1, 2, and 3.—Reported completed by Mr. Alexander. No 4 has had surveys made. Have not got it contracted. District is too short.

MR. W. D. ALEXANDER: I was engineer of Coddle Creek, or Cabarrus County Drainage District, No. 3. The work has been very successful. In the Piedmont section it costs more to drain, from \$15 to \$25 per acre. After draining, the land is worth from \$100 per acre up. I knew one tract to sell for \$100 per acre, and the purchaser paid the drainage tax.

Cabarrus Drainage District No. 4.—This has been started, but the acreage is so small I do not think they will ever let the contract.

Buffalo Creek Drainage District, No. 1, of Cleveland County.—Has been completed.

MR. N. L. CRANFORD: We have three districts in Forsyth County and two have been nonsuited. The one we have I suppose would be called the Middle Fork, South Fork, and Muddy Creek Drainage District.

Mecklenburg County Drainage Districts, Nos. 1 to 8.—Reported by Mr. Alexander as completed. No. 9 uncompleted.

DR. PRATT: In regard to this drainage in the Piedmont section, I want to say the first district started on Clark Creek in Catawba and Lincoln counties back in 1908 or 9, and it was before the drainage law was passed, and it was done by individuals. They did their own dredging, etc. We made an examination of the district, and worked out what it would cost. There was a meeting in Lincolnton, we asked if they could pay \$19 per acre for drainage, and they said, "Yes; we will pay \$25 if you will guarantee that the ditch will take care of the water." The engineers from Washington went over the ditch and said they thought it would. The first year after the work was completed they had one of the heaviest rainfalls that they had had in years; the people from the surrounding counties went over expecting to see everything carried away, and instead of that they found that the water had been taken care of, even under excessive rainfall. Seeing is believing and they went back and started work in the adjoining counties.

AFTERNOON SESSION

MR. M. W. THOMPSON, presiding: It has occurred to us that possibly some gentlemen have come in on the noon train who could make a report on some of the districts about which we have not had reports.

MR. SELLERS:

Back and Jacob Swamp Drainage District.—We have our district completed. It has given very satisfactory results. We have had it completed about three years, and a good deal of land has been cleared in the district. Some of the land which was utterly worthless sold for \$40 to \$50 per acre. Before draining, it was not worth \$5 per acre. We paid our first assessment last year, and had very little trouble in collecting the money.

MR. ABERLY of Craven County: Mr. Blades does not treat me right. Here I come up here more to learn than to say something. I was glad for that report this morning, in which the plan had been given us how to help ourselves a little better than the present law provides for. Up near Dover they finished a canal a year or so ago. Last year it was a very hard matter for these people to make up their assessments. In fact, I have seen a lot of property advertised for sale by the Association. That is a matter that causes more or less hesitancy for those that have

lands that ought to be drained to enter into schemes of having it done. It seems to me in order to put us people in the east in shape that we can help ourselves, the present arrangement of 10 per cent looks to be mighty heavy. If a body can drain his land and find a ready purchaser, or quick purchaser, or can convert that land quickly into earning power, it would be all right; but it seems to me we ought to be planning for giving the people a longer chance to pay these assessments. I know that right around New Bern they started a movement about a year ago, but it died, as we heard this morning of other places that died, and it seems that that part of it is more or less in the way. People are afraid to enter into such a big obligation. Our eastern section has so much swamp lands, and when drained to be carried on to success, it is necessary to drain many times such big areas, and the property owners that own these lands, unless they can find buyers right away, it puts them in an unwarranted position. I do not mean to discourage this work. I think we should arrange for legislation so that the work can be carried through.

MR. BLADES of New Bern: I think the State law can have nothing to take its place, and I am very much in favor of it. The Farm Loan plan will do lots for drainage. I believe that it will work out for the good of the farmers.

I was recently driving down what we call "Oriental way." I heard of a clearing that was very rich. I drove quite a distance. This has been drained by private enterprise entirely. I asked the value of that land. They said, "You cannot buy any of this land for \$100 or more." Other land near by was selling for \$10 per acre. This land, when drained, has such a deep soil that it is exceedingly productive for any number of years.

MR. THOMPSON: I notice our Secretary has assigned practically all the afternoon to a discussion of the North Carolina Drainage Law. For today's discussion we have a gentleman with us who has been at every drainage meeting of this Association, and he has had a large part in the formation of the law under which we are now working. He is a man who is known largely throughout the State. I do not feel that John H. Small, Congressman from the First District, needs any introduction to this audience.

REPORT ON BIG COLD WATER CREEK DRAINAGE DISTRICT OF CABARRUS COUNTY

By J. A. SCOTT, Secretary of District

The Big Cold Water Creek has been ditched and dredged about three years. Two good crops have been raised in the dredged district, and the third year, 1916, there was so much rain in the early spring and summer that the crops, or the greater portion of them, were drowned out. The ditch was not designed

to take care of extraordinary floods, and during the past year the water has gone out of the channel and covered the low-lands in the bottoms in some places. Notwithstanding these extraordinary floods, the ditch is now in fair condition; the upper end of the ditch has considerable sand in it, caused by some large branches emptying into it at this point; in the lower end of the ditch sand has accumulated in it, and the remainder or the middle section of the ditch is now in good condition and is as deep as when originally dredged.

In places where the main channel is cut very near the steep hills on the sides, in case of high floods, the water breaks over the channel at these points and runs across into the lower lands, causing damage to the banks of the channel, and leaves sand at these places of "break-over."

We have some wet land belonging to persons in the district who cannot drain their own lands in the main channel without crossing over lands of others, and in such cases the land is not benefited by the dredging.

All obstructions have been kept out of the channel by the commissioners. As much as seventy bushels of corn per acre has been raised on the dredged land in this district without fertilizer, and an enormous crop of corn was raised on the land in this district in 1915.

From the health standpoint, the dredging has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. From an agricultural standpoint, the drainage of this district has been a success, and the ditch has maintained itself as well as those who favored the project had hoped for in the beginning.

REPORTS ON DEVELOPMENT OF INDIVIDUAL DRAINAGE PROJECTS

NEWPORT NEWS, VA., October 17, 1916.

HON. JOSEPH HYDE PRATT,
North Carolina Drainage Association,
Chapel Hill, N. C.

DEAR SIR:—I appreciate very much your invitation to attend the Ninth Annual Convention of your Association in Greensboro in November, but fear there is little chance that I can be present.

In connection with drainage in general, I would like to invite your attention to a condition that seems to me to have the effect of discouraging large drainage projects, and one that should receive the consideration of the State authorities interested in agriculture, drainage, and colonization.

The Norfolk and Carolina Development Corporation owns about 4,000 acres of land in Perquimans County which has been drained by means of about ten miles of canals averaging about 20 feet in width, under the laws of your State, the cost having been covered by an issue of \$30,000 of drainage bonds. This land lies along the branch of the Norfolk and Southern Railroad which extends west from Elizabeth City, and other lands not owned by this company are also included in this district.

The drainage project has been completed and the land is dry and ready for settlement, but we have been unable to dispose of it, although we have offered portions of it at \$10 and \$12 per acre. It is understood that land in some of the other drainage districts is selling at \$50 and more per acre. The canals show soil of great depth and richness, and I believe this land will be very profitable to settlers. The low prices for which it is offered seem to me an

evidence of liberality on the part of the company that should dispel any idea that the company is seeking exorbitant profits.

It is possible that the company has not given its property as much publicity as it might, but it seems to me that the State agricultural and colonization authorities might investigate this property, and, if the soil and other natural conditions are as favorable as we believe they are, could induce settlers to take up some of this land, thus affording a valuable demonstration of the richness and productivity of your eastern lands that would be of great benefit to your State.

The drainage tax assessments per acre for ten years until the bonds are retired will be much less than the cost of fertilizer required for most agricultural lands.

It seems to me that the interests of the State require the same effort on the part of its authorities to insure the success of a drainage project by assistance in colonization after completion as are used to initiate the drainage project, and it would be deeply appreciated if you can see your way clear to bring this to the attention of the proper State authorities to the end that our property may be given a thorough investigation, followed by their coöperation in the development of it if the results of the investigation should warrant it.

Mr. R. Page Waller, 551 Warren Crescent, Norfolk, Va., is president of the company, has recently been over its property, and will be glad to communicate with any authorities you may suggest.

Thanking you for any suggestions or good offices you may extend in this matter, I am

Very truly yours,

(Signed) JAMES W. SIMS.

BAYBORO, N. C., October 31, 1916.

MR. JOSEPH HYDE PRATT, *Secretary-Treasurer*,
Chapel Hill, N. C.

DEAR SIR:—We have your announcement stating that the Ninth Annual Convention of North Carolina Drainage Association will be held at Greensboro, N. C., November 22 and 23, and the writer expects to attend this Convention.

I would like to state that we are developing in Eastern Carolina a section of country by a very unique method; in fact, we do not know of any other project which has been put through under similar conditions. We have several thousand acres of land in the counties of Pitt, Beaufort, and Craven, which we are draining for a portion of the land involved. As you no doubt know, there are thousands of acres of land in this section of the State considered worthless by the landowners, in its present state. In a great many instances they own large tracts of land which they do not care to put in a regular drainage district organized under laws of the State, and be taxed for the improvement, but they are willing to give a portion of this land which they own to some person, firm, or corporation who would be willing to go in and develop the property along these lines. The landowner figures that the land in its present condition being worthless, he has all to gain and nothing to lose by the proposition, and in this way thousands of acres can be reclaimed in Eastern Carolina, without the regularly organized district, it being simply

a question of getting capital with sufficient confidence in the future development of the section to take hold of the proposition.

After the completion of the original construction work, it would be a good idea to organize a drainage district for the future maintenance of the system.

Mr. C. G. Elliott of Washington, D. C., has been our consulting engineer on the proposition which we have undertaken, and Mr. Elliott pronounces it most unique.

We are getting along fine with same and have great confidence in future developments along these lines. I thought I would mention this to you, as I doubt whether or not you have ever heard of such a proposition being put through. We have over one hundred and fifty landowners involved in this drainage scheme.

Yours very truly,

(Signed) C. W. HODGES.

NORTH CAROLINA DRAINAGE LAW

By HON. JOHN H. SMALL, Congressman from the First District

Mr. President and Gentlemen: All I may hope to do during the brief hour I shall occupy your time this afternoon is to bring to you a few sheaves of thought gathered from a very busy life which may be applicable to the deliberations of this Convention. I do not think I can preface my remarks in any more appropriate way than by directing attention to the most interesting proceedings of this morning's Convention. Much is the pity that hundreds of farmers, landowners, and forward-looking men in North Carolina who are interested in this great subject of reclamation and conservation of the resources of land could not have been present to have heard the discussion. Not least interesting were the very appropriate and well expressed remarks of the President of the Association. I take great pleasure in referring to the remarks of the President, because he is a native of my own county and one of the progressive citizens of eastern North Carolina. His activities are not confined alone to words; he is the most efficient chairman of the Board of Drainage Commissioners of the Pantego Drainage District. He has taken an active interest in this great movement for drainage, and is probably as well acquainted with the details and workings of the present law and the amendments which are necessary as any citizen of the State.

I have been asked to say something regarding the proposed amendments to the drainage law, and I shall first speak about the law in its present shape. This law has worked well in North Carolina. It was the first instance where we attempted to translate into law and into works the spirit of coöperation in the drainage of our lands. Heretofore, as Mr. Camp said this morning, it has been the case of each individual landowner attempting alone the solution of the problem of land drainage, with the result that, except in isolated instances, there had been few illustrations of efficient drainage of land. This law recognizes the proposition that land drainage of necessity must be applicable to large areas owned by many individuals or corporations, and that they must unite in order to secure, first, the most economical drainage, and, second, the only means of securing efficient drainage. Many times references have been made to the law as being cumbersome and complex; and the criticism is true, and those who desire to amend the law by simplifying its provisions

and making it more plain to the laymen, and less difficult to follow by the average lawyer, have laid their criticisms well; but unfortunately it is probable that their desires cannot be entirely accomplished. This law is based on a fundamental proposition that some landowners have the right to impress their lands and the lands even of unwilling landowners with a public use or burden. We are one of the oldest States in the Union, and our statute law and the law as formulated by our Supreme Court during its entire history has tended to throw around the ownership of land and all other property every opportunity for the assertion of individual rights for the protection of their property; and this had to be kept in mind in the drafting of this original drainage law, in which I had the honor to take a leading part. The principle embodied in the law of our State, that whenever you attempt to put a burden upon the property of another, an opportunity must be given to the owner of that property at the different stages of the proceedings in which you are attempting to put the burden on it to come into court and make any objections to it which he thinks might be valid, and have these objections passed upon by a court of competent jurisdiction. If I have expressed myself clearly, it means this, that at any stage of a proceeding, where a financial burden or a public use of any kind is sought to be impressed upon the property of another, the owner of that property must have his day in court to assert what he thinks are his rights; so that in the drafting of this law it seemed necessary to recognize that principle so prominent in the law of North Carolina, and that is the reason for much of the prolixity and apparently numerous opportunities which are given to landowners to make objections and have these objections passed upon by the court; and in any amendment to this law that feature of our North Carolina law must be rigidly kept in mind. For instance, a drainage law applicable to one of the new States of the Union, like Ohio or Minnesota, or even Arkansas, would not be applicable to North Carolina, because those are new States coming into the Union long after North Carolina, one of the original States, with constitutions somewhat different. A law that would be valid in those States would stand in great danger of being declared invalid by the Supreme Court of our State, owing to the fundamental feature of the law of North Carolina regarding the rights of those who own property, when it is attempted to impress upon that property any burden or public use. There is this to be said about the present law, that with one exception all the attacks which have been made upon it have been unsuccessful, and it has been substantially sustained. The only exception lay in one provision which attempted to exempt from taxation the bonds of a district. That was inserted with grave doubts as to its validity, and it was this section that was afterwards declared invalid by the Supreme Court.

The law has wrought well in the economic welfare and progress of the State. I read in the *Greensboro Daily News* this morning a most interesting interview with Dr. Pratt, in which he stated that the operation of this law with districts which had already been fully established, and now in operation, and with districts which are in process of formation and about which there was no doubt as to their completion, that it will have added to the tangible wealth of the State at least the sum of fifty million dollars. In other words, it has added to the State that which can easily be capitalized by all the rules of finance, an increase in the wealth of North Carolina to the extent of that

large sum of money. Any law which has worked so well is certainly entitled to commendation.

There are, however, some amendments which experience has taught us are necessary. To recite these amendments in an informal address would be both impracticable and uninteresting, and I shall only attempt to mention one or two of them and leave to subsequent queries which may be propounded further discussion of details.

There is one defect in the law which is transparent. Tracts of land included originally in drainage districts have changed title by deed or by devolution upon the death of the owner or by involuntary devolution through foreclosure of mortgages; and very frequently these lands have been divided and are now owned by two or three, or sometimes a dozen different owners. There is no provision under the present law by which there may be a reassessment of a drainage tax so as to separate the tax upon the different parcels of land into which the original tract has been subdivided, so that it is left to agreement to make a division of the drainage tax among the new owners. Where all are disposed to be agreeable and fair and just, an agreement can be made; but very frequently that is impossible, with resultant confusion when it comes to the payment of the drainage tax. Under the present law the original owner, or at least the original land as a whole, is bound for the original drainage tax as imposed in the drainage proceedings.

Many have suggested that there ought to be a larger number of classes into which lands are divided, thereby varying the proportion of the drainage tax. That has been particularly observed in those large bodies of swamp lands in the east which have been reclaimed, surrounded as they frequently are by land reclaimed many years ago, and where the differences in the proportionate liability are so marked that the present number of classes (6) do not represent sufficient elasticity in order to cover all the proportions of liability, and it is believed that an increase to at least eight classes would be better in the administration of the law.

There is nothing in the present law which provides a length of term for the Drainage Commissioners. Their terms ought to be fixed, and there ought to be some method of compensation, particularly for the Chairman of the Board of Drainage Commissioners, with some per diem for the members of the board whenever it becomes essential for them to meet to transact the business of the district. The position of Chairman of the Board of Drainage Commissioners is an exceedingly important one. During the latter stages of the formation of a district his duties are numerous and responsible, and after the drainage district is established questions are constantly arising in the administration of the law. Questions of reassessment for the maintenance of the district arise, and that officer is the executive head of the district, corresponding to the president of a corporation, and ought to be a man of affairs, with administrative capacity, and he ought to be paid a reasonable compensation for his time and talent devoted to it.

I can see how dry this is by looking into your faces, and if I were going into further details, it would be even more stale and less entertaining than these provisions I have just submitted to you.

To be personal just a moment, I had promised myself, and had so expressed to Dr. Pratt and perhaps others, that I would endeavor to redraft our entire drainage law, and to that end I gathered the drainage laws of a number of

States last summer. I secured the drainage laws of Arkansas, of Missouri, of Wisconsin, of South Carolina, of Georgia, and of Louisiana, and I devoted all my nights for a week to studying these laws, and I became convinced that while it is a most desirable consummation to redraft our law, simplify it to as great an extent as possible, consistent with our own local conditions and laws in North Carolina, yet it would require at least some weeks of constant work to complete same. To illustrate, take a competent lawyer who may undertake to redraft the law. If he is a wise lawyer, he would include the best provisions in the laws of all the States, having regard for clearness and simplicity. He would then test the same by the Constitution and decisions of our State, to the end that it might be both workable and valid. I have expressed enough, I think, to convince you that it is quite a task, so that so far as I am concerned, with the demands upon my time between now and next March, I shall not be able to carry out the promise I made to myself; but I intend immediately to take all the suggestions submitted to me by Dr. Pratt with those sent in by others, and draft certain amendments to be submitted to our next Legislature, soon to convene, and Dr. Pratt will submit them to the Legislative Committee and to intelligent men throughout the State with a view to eliciting further suggestions. While this is somewhat personal, I simply express it for your information, and that you might know that progress is being made and that the plans in mind promise that these amendments will be ready to be submitted to the next Legislature.

Gentlemen, how may we promote the progress of this drainage movement in North Carolina? I listened sympathetically this morning to the remarks of gentlemen from different counties who spoke about their experiences. The gentleman from Sampson County, the very progressive gentleman from Forsyth County, and others who, in the face of efforts upon their part, perhaps with the coöperation of some other landowners, had yet failed to translate into reality their aspirations for the establishment of drainage districts in their respective localities. I ask, Why does that condition exist? I suspect that probably the primary cause is due to what Mr. Camp said this morning. We have cultivated for more than a century in North Carolina individuality, personal independence, and have neglected to inculcate into the minds and consciences of our people the necessity for coöperation. I was delighted to see in the meeting of the North Carolina Farmers' Union the other day in Raleigh, as reported by the press, this subject of coöperation stressed and emphasized, because in it lies the solution of so many of these pressing problems, in which are involved the welfare and progress of North Carolina. We cannot have churches without that spirit; we cannot press forward in this movement for building and maintaining better highways unless we have it; until this spirit was engrafted upon the consciences of the people of North Carolina we never had any public school system worthy of the name. It is only through that spirit of coöperation that thousands of rural and urban school districts in North Carolina have voluntarily levied upon themselves local taxes to supplement the general school fund to provide better school buildings, longer terms, better trained school teachers, and teachers at a living wage; and we will only solve this drainage problem when we have shown the landowners that drainage is not an individual burden, but a community burden. I think that constitutes the basic difficulty which these gentlemen have found in the establishment of drainage districts in their respective

sections. You cannot overturn the viewpoint of a people established by the teachings of a century by any immediate process. Just as it required time to create the erroneous thought, just so will it require time to remove it and substitute for it a more generous and profitable thought. Only by the educational process will we be able to bring about that condition of the public mind which will induce landowners to change their viewpoint and cooperate with other landowners in the establishment of drainage districts. To him to whom much has been given, much will be expected, and we to whom have been given not only native intelligence but education as well, and a cultivated mind, we who have been brought into the new atmosphere of light and knowledge, upon us is incumbent the duty of being leaders in these educational processes, which shall convert individuality into cooperative endeavor. I may refer to another handicap in the fact that some citizens substitute prejudice for intelligence. How many men do we find, when we seek to advance a cooperative activity, who express as their first thought upon the subject not the merits of the proposition, but the fact that they dislike some one connected with it, or that in some way something has occurred to arouse their prejudice! The most difficult combination against which progress has to fight are ignorance and prejudice; combine the two together and you have an obstacle which is nearly insurmountable. I doubt not that in the experience of these gentlemen who have spoken this morning, and in the experience of others of us who have attempted to be observant of these activities going forward in the State, that these constitute the chief difficulties. We must have the patience of Job, must emulate the wisdom of Solomon, and must have the persistence necessary in all good undertakings. I heard a man say in politics (I won't say to which political party he belonged) that the way to get a North Carolina electorate aroused was to appeal to their prejudice. I hope he was not telling the truth. The trouble was he thought he was speaking the truth. It ought not to be true either in government, which is only another name for politics, and we ought to enlist in the army of intelligence with the purpose of eradicating this prejudice and substituting for it the generous light of intelligence.

In conclusion, I would like to ask why so small an attendance at this meeting? May I express what to me is a doctrine which ought to inspire every citizen? I believe it is the solemn duty of every man and woman to select one or more public activities, more than one if possible, which are intended to promote the public welfare and to serve humanity, and to devote to these activities the best they have in time, in talent, and in means. I further believe that upon every citizen whom the people have made their public servant, whether they serve in the humblest or in the highest capacity, that it is doubly incumbent upon him to engage in the activities which make for the public welfare. I would like to see abroad among our citizenship in North Carolina an ideal of service of that kind, not only applicable to themselves, but applicable to every one of their public servants, whether they be municipal, county, State, or Federal.

Now here is an activity in an economic sense greater than any other. Here is an activity which directly adds to the wealth of North Carolina in the proportion with which we prosecute it. As a matter of fact, we provide public schools, and yet in doing so we know we provide for the next generation, and only by reflex upon our own. Here is something that affects all of North

Carolina; our level alluvial lands in the east, these rich bottoms in the Piedmont section, and in the mountains. There are hundreds of thousands of acres of land in this area which ought to be immune from damage by water, which might be drained, and will be when we properly appreciate its importance. Why are not the men from eastern North Carolina here? and I speak because it is my section. There are hundreds of men down there who have been the beneficiaries of this law and know its benefits. Why are they not here? They represent the type of citizen who does not care to bring to other North Carolinians the blessings which they have received. No matter where we may meet in North Carolina, we ought to have a large attendance of forward-looking men from every section of the State. I do not think there is any danger of the Association dying a premature death; I think there are men who will stand by it till the end, until its blessings are scattered throughout the entire length and breadth of our State. But we do not wish to wait indefinitely. We wish to hurry forward the day so that we shall enhance that reputation which we enjoy as being one of the forward States in the South as well as in the Union. Because we have been slothful in so many things, and indifferent so long to the utilization and the development of the great resources of our State, is no reason why we should continue in that condition, but with the present light and knowledge which we possess of the benefits which will accrue, we ought to impress upon ourselves and on others that zeal and love for service without which some of the greatest blessings cannot come to the people of the State.

Gentlemen, I was asked to talk to you on the Drainage Law, and instead of that I have occupied most of the time preaching. It may be that a little sermon of this kind, if it is righteous doctrine, will be of some encouragement and will hasten the day when we may enjoy the full fruition of this movement, and thereby greatly add to the wealth and progress of this good State.

DRAINAGE FINANCING

By BRUCE CRAVEN, Attorney-at-Law, Trinity, N. C.

It is generally believed that any discussion of finances is a dry subject, and therefore it would appear that the subject of Drainage Financing would be doubly dry, since the purpose of drainage is to make things dry; so you, in the generosity of your hearts, will have to bear with me in the presentation of a few plain, pertinent facts regarding a very vital element in this truly great work of turning the waste places into paradises of plenty and beauty.

It happens that in the practice of law, a very large portion of my time and attention is in connection with municipal bonds in North Carolina, and has been for some time. It is an open secret that drainage bonds, as issued in North Carolina, are the least desirable of all such securities, and for the good of the work throughout the State, some remedy for this should be found. Unfortunately there is not much business attention given to the financial end of a drainage project, and hence a good part of the money is thrown away. For one thing, there is usually a great effort to sell the bonds at a high-sounding price, and not enough attention is given to the more important point of getting the best and the cheapest contractor to do the work. There is little system about the whole business, and lack of system means direct loss in any enterprise.

The difficulty about the bonds is the low assessed valuation back of them. The ultimate investor in securities must know from the financial statement that his investment is not only safe but absolutely and unquestionably perfect. The usual basis of valuing securities is that the total bonded debt against any district should not exceed ten per cent of the assessed valuation; the usual drainage district as compared to this has a debt of anywhere from 25 per cent to 100 per cent of the assessed valuation. In the usual course of the bond business this class of securities cannot be handled.

The first remedy ever suggested was that the owners of the low-lands should include in the district their whole farms. This is impracticable for two reasons: first, it would be an unequal burden on the basis of the benefits of the drainage; and second, it would increase the opposition on the part of the few objectors who nearly always try to prevent the improvement.

A second suggestion is, that after the drainage district is formed the property inside of it should be re-assessed at a high valuation, so as to make the assessed value at least five times the amount of the debt. The objection to this is that the increased assessment would apply as well to all other taxes as to the drainage tax. For this reason this suggestion is impracticable.

There remains only two possible recourses, and these are two methods of one general idea, and it should have your most earnest consideration. The main idea is that the county assume the obligation of the debt. Let the drainage district be named numerically according to the county in which it is located. Model the bond provision after the State-wide road bond law, and have the bonds issued and sold and signed by the county commissioners, and the taxes levied and the interest and principal paid by the county commissioners. The county in this law can assume the guarantee of the debt, and this will result in making it a direct obligation of the county, and all the dealings on the part of the bondholder will be with the county, and he will have nothing to do with local district officials. The other method in the same general idea is for the county to take up the drainage bonds and issue direct county bonds in place of them, holding the drainage bonds as security. The first suggestion, however, is undoubtedly the better one.

What would be the result? It can best be told by comparison. I personally know an owner of land inside a drainage district who has money out at interest at 6 per cent. If he paid taxes on that money, his net income from it is about 5 per cent, together with the risk of loss and the annoyance of attending to a private loan. The same man as part of the drainage district is at the same time paying 8 per cent interest on the outstanding debt against the district, though the debt is a public one and safe and free from annoyance; and he is a good, common-sense business farmer.

The drainage bonds, on account of the very low assessed valuation, were sold at ninety cents on the dollar. They bear 6 per cent interest and average five years. The real interest, therefore, paid on the money actually received is 8 per cent, and the bonds are practically free from taxation. While not legally exempt from taxation, yet I would not like to depend for a living on the taxes paid on the millions and millions of dollars of such bonds now outstanding against different bond districts in North Carolina.

If the county in which my friend lives should do its full duty it would make my friend list his solvent credits at their full value and pay taxes on them, and then it would assume the obligation of the drainage bonds and take the re-

sponsibility, which it could do without any possibility of loss. The result would be a benefit to every one concerned, even to the county itself. The drainage district would be the most benefited, because it would sell those same 6 per cent bonds at a good premium, and thus add about 15 per cent to the amount of actual work done for the same money, and no one would lose anything. This is what I call business methods in public office, and it is a method that should prevail everywhere.

Two ideas have been advanced along this line that are plainly erroneous. One is that the drainage project cannot be aided by the county because of its being in the nature of a private enterprise. Among lawyers, at least, that idea is too far afield even for discussion, as there simply isn't any doubt at all about drainage bonds being public just as much as any other bonds; and the county or the State can guarantee any or all of them if it will, and I have yet to hear of any reason why it should not do so. The other erroneous idea is that the situation could be helped by making the bonds redeemable at any time at the convenience of the district. This not only would *not* help, but would further depreciate the value of the bonds. The term of years as it is is very short for a security which is bought as a permanent investment, and the suggested change would make them considered as one-year bonds, as they could be taken up that way if desired. The term of years as now prescribed is short enough, and if the bonds could be guaranteed by the county as advocated, it would still further add to the value to increase the term to fifteen years or even twenty. However, this should not be done without the guarantee by the county.

It has been well said and often said that "the shoemaker should stick to his last," and it is well to remember this in connection with revising or amending any law. It should be done only by those who know what they are doing, and what they want to do, and how to do it. The drainage law should be handled by men who know the drainage law. A careful comparison of the North Carolina law with those of other States convinces me that our law is the best working law of them all. Perhaps it needs some changes, but it is better to leave it as it is than to have amendments tacked on to it by a legislator who knows nothing of the law except the one little hobby that happens to be in his mind.

The drainage work, as represented in this Association, is a great and useful work. It is true work, because it is creative. It is making new wealth in our State, and therefore benefiting all the people. The whole people should be interested in any movement that tends to produce wealth, and the new generation in North Carolina will look for leadership to the leaders who stand upon these principles and really lead the fight for better economic conditions for the whole State and the whole people.

DISCUSSION OF NORTH CAROLINA DRAINAGE LAW

DR. PRATT: I am not going to try to make many suggestions in regard to the amendments or changes to the North Carolina Drainage Law. I want to go back a little bit, to 1909, when the drainage law was passed, and answer to a certain extent certain questions that were raised by Mr. Small. I am going to ask a question myself, and then answer it. How

was the drainage law passed in 1909? If you could take the drainage law as we published it after the General Assembly of 1909 adjourned, you would find that there was not a single change in any section of that law from the time that it was introduced until it was passed and ratified by the General Assembly of 1909. Not a single amendment was made to any section of the original law as it was introduced into the General Assembly of 1909. How was that done? It was because the North Carolina Drainage Association got back of that law, went to Raleigh, not only three or four men (as Mr. Small said, three or four men stayed there all the time) at the hearings before the Committee of the House, but there were at least twenty or twenty-five members of the North Carolina Drainage Association to back up the bill after it had been introduced. Our chief fight came in the House. As I remember it, there were twenty-nine amendments suggested to that bill, and each one of them was voted down. When they finally got to the ninth or tenth amendment it got to be a laughing matter. It was because this Association realized the value and need of that drainage law, and the Legislative Committee of this Association, composed of some of the very best lawyers in North Carolina who were interested in North Carolina and in drainage work, spent months and months drafting and redrafting that drainage law, to make it, as far as they could, the most effective drainage law that could be obtained for the State of North Carolina. Representing your Association, they went before the General Assembly of 1909 and told them through your committee that they did not believe it was possible for the General Assembly of North Carolina to give to this bill more thought in the sixty days they were there than these people had given to it in months of work. So it was passed as it was presented. We were able to convince the committee of the House that that law was in the interest of the people in the drainage sections of the State, and that they wanted and needed it as it stood. In 1911 we passed a few amendments. Certain ones were suggested, but we did not have the same backing of the Association as in 1909. The Association felt that the drainage work would take care of itself, because already the drainage law was passed. But what I have been working for ever since is to get this Association in such standing throughout North Carolina as to make the people and legislators realize that what they demand passed as amendments to this drainage law are for the best interests of the drainage work in the State. It is just as bad for the North Carolina Drainage Law to be amended without our suggestions as it is not to pass the amendments that we recommend, and I believe if you could put back of this Association the same force and determination that we had in 1909, we could convince any General Assembly that this Association

knows what is needed in regard to amendments to the North Carolina Drainage Law. I mean the State Drainage Law; we have nothing to do with the local drainage laws. There are two or three members of the General Assembly of 1915 here today, one from Robeson and one from Durham County, who were in the House. They will probably remember that we had drawn up through our Legislative Committee certain amendments to be presented to this Legislature. They were introduced into the House, went before the Drainage Committee, and, if I remember correctly, there were several on that Drainage Committee who were anything but favorable to the drainage work in North Carolina, and that committee began at once to try to pick to pieces and amend and change the proposed amendments of this Association, and it looked as though nothing would go through as proposed by the Association. It was finally thought best not to try to pass anything rather than to pass the amendments that were being proposed by the committee of the Legislature. The point I want to bring out is this: that if we had had last year, before the Legislature of 1915, the same backing and determination to have our amendments passed as we had in 1909, when the drainage law itself was passed, they would have been passed, because we could have gone before the committee and impressed them with the necessity for this law and the strength of its backing. There was one amendment that passed which was not recommended by the Association. This amendment was introduced, and by the time it came out and was ratified, instead of doing as it was supposed to do and amend section 11, it repealed section 2. That was taken up to the Supreme Court, and it was decided that without question section 11 was the one to be repealed.

The point I want to bring out is that if we are going, as an Association, to try to have the influence that we ought to have in framing legislation regarding the North Carolina Drainage Law, we have got to get together in larger numbers than we are here today. We have got to go to Raleigh and work for these proposed amendments.

MR. THOMPSON: Whatever we decide on, it is very hard to get it enacted into law. Before we adjourn I hope we will have some concrete plan presented that will insure a large attendance over at Raleigh.

MR. JOHNSON: I am frank to say that the gentleman who preceded me could have said all I know to say about this drainage law. I can only emphasize some of the points that have already been mentioned by telling about the actual application to our district. The most vital objection to our law as it stands now is the lack of any provision for releasing the land that has been sold. I will mention one instance. In our district we have one tract of land which is put down to a man named Luther Lynn, and there are now sixteen different people who own an

interest in that land. Last year Mr. Lynn went to the sheriff to pay his taxes, and he was told that he had 90 acres on which to pay tax. The sheriff was compelled to say, "I cannot release you from the payment of this small sum, because the payment is so much and is based on 90 acres of land." I own an interest in this land, and I offered to pay my part to the sheriff, and in looking over his books he found I had no interest whatever, and therefore he refused to give me a receipt. A number of others did likewise; and to this day the matter is unsettled, and it looks as if we will have litigation in the end, because the whole tract was sold to settle this one small claim. It is my idea that once a year prior to the time when the sheriff collects these drainage taxes, that the books shall either be remade entirely or revised in such a manner that the present owner of each tract of land shall be stated on that book, always keeping in mind the revenues of the whole number of acres and the total tax in accordance with the bonds already issued. It is my opinion that the chairman of the drainage district is the one with whom this change should be registered; but it does not matter who does it; somebody should be designated to make this change.

In connection with this revision of the law, there is another point which has not been mentioned. You know that one type of land may be assessed in five different classes. Now, there is no physical marking on the drainage map to show these different classes, and there is no reference in the tax assessments to the different classes under which one body of land is placed; that is, which part is Class A and which part is Class E. Naturally, a man who has bought land out of a tract having these various classifications wants to believe that he has bought the lowest class land, and it is absolutely essential that some one have charge of this work and know into what class this land is placed. There should be some physical mark on the map showing exactly where these classes are located. It would be more expensive to do this, and will take more engineering, but I am satisfied that in the end it will give more satisfaction.

The election of commissioners is provided for, but as Mr. Small has well said, there is no term of office fixed, there is no provision by which a commissioner can resign, be removed, or, in case he quits anyhow, another be elected. I believe their term of office should expire at some definite time, and provision be made for others to be elected. As to the compensation for the commissioners, we cannot, I believe, fix a compensation for all the districts, because the chairman of some district may have a great deal more work to do than others; but, generally speaking, the chairman is the man who has the most to do, and is the one who should be paid. I believe if the commissioners were

paid for their work they would take more interest in the work than they do now. You see, as the matter stands now, the commissioners have to serve whether they would or not, and are not allowed any compensation for the time spent on this work. They take this attitude, "You people got us into this thing; you ought to get us out."

I want to say that I would have been willing to come all the way to Greensboro to hear the fine words Mr. Small said about me, because I have had to contend with everything except lynching in connection with the drainage work in our section. It gives me great pleasure to say, however, that barring this one trouble in the listing of taxes, almost every person in our three districts has become reconciled, and I believe that if the question were put today there would not be three persons who would eliminate the whole thing and go back to where we were three years ago.

I have attended several sessions of the Legislature, and have been a member a number of times of a Drainage Committee, and I do not think that our lawmakers are antagonistic to our drainage law; but they do not understand it, and we have not taken the trouble we should to educate them. I believe it is our duty to educate our lawmakers, to show them the value of this drainage law, and to show them the necessity for certain amendments which we think are necessary to make the law more effective; and so I think this Legislative Committee of our Association must take the time to properly formulate these amendments that we need, and properly present them to the Legislature.

MR. FULLERTON, representing Tilotson & Wolcott Company, Cleveland, Ohio: I do not know that I can add much to what has been said. I agree thoroughly with Mr. Craven in regard to what he says about the bonds and the profits that the bond dealers have to make as distributed over a period of years. In regard to making the bonds more salable, his idea of making them county obligations would be very good if it can be carried out. I think there would be a good deal of opposition to this in the counties. It would make the bonds more salable, however. It is done in Florida and Tennessee. They are not exactly county obligations, but they are signed by county officials, who guarantee the collections, and they are levied the same as other taxes, by the same officials. These bonds are better thought of than the bonds which are put out by the commissioners. That is, have the county officials sign the bonds and take care of the collections. In that way I think it is a matter that could be gotten through with the people. I think you have a very good law as it stands. Of course, if you were to include the uplands, it would increase the value of the bonds; but I believe it would be almost impossible to do that.

MR. THOMPSON: We have found that if we tie up some of the other land in the bond, that is, some of the land adjacent to the creek bottoms, that we have a better bond because of it.

In connection with the point Dr. Pratt brought out, about bringing matters before the Legislature in a favorable way, it is suggested that we might have a midwinter meeting in Raleigh. I believe if we could get a meeting of the Association at that time, we would be able to get what amendments we wanted put through, and I believe that we ought to give Dr. Pratt more support.

MR. SMALL: I think every suggestion seriously made ought to be seriously considered. I was very much impressed by the suggestion of Mr. Craven, supplemented by the suggestions of Mr. Fullerton. The point made by Mr. Craven that the solvency of the bonds would be very greatly increased if made the obligation of the county is unquestionably correct; but the only trouble is in giving it this obligation. I will point out one or two defects.

My observation has been that frequently in the legal proceedings for the establishment of districts the lawyer representing the district has not been careful to observe all the requirements of the law, the result being that when a certified copy is made of the record and sent to the attorney of the proposed purchaser of the bonds, usually some banking house, it is referred to some attorney who has made a specialty of the study of not only drainage, but all other classes of municipal bonds, or sub-agencies of the State. He has full knowledge of the law, having it before him, and having studied it with a critical and trained eye, he observes whether the law has been literally complied with, and if it has not been in all respects, he will make a note of it, and ordinarily will pass unfavorably upon the bonds because the law has not been literally observed. I have even observed instances of this kind, where the local attorney representing the district had failed to observe, or the record had failed to disclose, that a certain direction of the law had been observed. The local attorney had said that according to some decision of the Supreme Court of North Carolina it is presumed to be done. A bond attorney is not content with that; he wants the record to say that the law has literally been observed. Now, coming to my point: If in this way a drainage district is established, bonds are issued, and the bonds are turned over by provision of law to the county treasurer to collect, and the county issues its bonds, say at 5 per cent in lieu of the 6 per cent bonds of the drainage district, the county getting that profit of 1 per cent for its assumption of the liability, this condition would probably result, that the county would not have been as careful in examination of the law to see that the latter has been complied with as

this trained attorney, and it may be that there would be such a serious difficulty in the establishment of that district as to impair the validity of the bond of the drainage district. Now, if the county attorney would be as critical in his examination of the records as the bond attorney, he would be charged with being over-critical, fault would be found with him, and he would have a very difficult task before him. If, on the other hand, the record was not critically observed, and some vital defect overlooked, and there should be a default in the payment of any drainage taxes, and the county should institute proceedings to compel the payment of the drainage taxes, you could not rely upon the fact that because this was being done by the county, some landowner would not take advantage of that defect. He would go to some smart lawyer who would tell him that the validity of the bond issue could be successfully combated, and there might be an instance where the county would be liable for its own bonds, and yet not be able to indemnify itself for this expenditure out of the bonds of the district. If we had some method by which the same critical knowledge and trained study of the record of the district could be made as at present by some of these trained attorneys in the cities, the situation would be different.

I have just put a practical defect before you, which I am sure Mr. Craven will appreciate as well as any of you; so that it may be we will have to adopt the suggestion made by Mr. Fullerton: that is, have the bonds issued or rather assigned by the officials of the county, and then, as he says, an assessment collected by the officials of the county, to be turned over to the bond dealers, and, as suggested, the taxes collected by the same official who collects the State taxes; the treasurer of the county would be *ex officio* treasurer for the district. This seems to me about as far as we could safely go at this time, and we would have to change the law so that the bonds could be assigned to the county commissioners.

MR. ALEXANDER: There is one point right along where Mr. Small was talking. In organizing a district in Forsyth County, I suggested to them to let the county stand behind the bonds to make them more salable. They framed a bill at the last Legislature, and started to introduce it, and were scared off in some way. They were told that something conflicted with the Constitution of the State; that it was not constitutional for a county to stand for a private enterprise. If that be the case, it would not be possible to do this.

MR. SMALL: I think the formation of a drainage district implies subjecting private property to public use sufficient to take drainage bonds out of the class of private enterprise.

MR. ALEXANDER: Another point is about bringing in hill land. A good many districts in the Piedmont section, which have gone as much

as a half-mile from the edge of the bottom-land, take in the hill-land for the benefit to the bonds. We think that land is benefited from the standpoint of health. In other districts we have gone a half-mile from the stream, and in others we take an acre of hill-land for each two or three acres of bottom-land, so that it will not work a hardship. We have an understanding that that is to make the bonds more salable. It does not cost the individual any more, but we put the land in to guarantee the bonds. A case has been carried to the Supreme Court in Georgia where an equal acreage was taken in.

MR. SMALL: The highlands adjacent to the lowlands? The man who owns the highlands is in a position where the water must flow from his land to the lowland. He is known as the dominant owner, and the man in the lowland is the servient owner. Is there any right in law for the man above to put his water through the bottom-land in order to reach the common exit, without paying compensation? In other words, is not the owner of the bottom-land entitled to some rights in the matter? [There followed a discussion among several as to the relative legal rights or moral rights of the dominant and servient owners of land, which was not taken down.]

THURSDAY, NOVEMBER 23—Morning Session

The meeting was called to order by the President, Mr. P. H. Johnson.

MR. JOHNSON: I notice several representatives of railroads present, and I am sure we will be glad to hear from some of them. I take pleasure in presenting Mr. E. E. Hunter of the Seaboard Air Line Railway.

MR. HUNTER: *Mr. Chairman and Gentlemen of the Convention:* I want to make the statement that this is the first attempt I have ever made to speak in public, and when I presented my credentials I stated that I hoped I would not be called upon. Our people, of course, are vitally interested in this drainage question. Our President and Vice President express their regrets that they are not able to be here in person. We have recently organized a Land and Industrial Department, which is especially interested in the drainage question, and wants to take a much more active part than ever before. Recently our President went to Wilmington, and I rode back with him as far as Hamlet; passing back from Wilmington to Lumberton, he asked me why the country had not been developed. I told him that I could answer his question in one word, and that is drainage. Our newly appointed Developing Agent, Mr. Hamner, has also had considerable correspondence with me relative to this drainage development. I am confident that under his direction the Seaboard will take a much more active part in drainage

work than ever before, because we appreciate now that this is a vital question to the railroads, as well as the landowners of the State.

MR. JOHNSON: Dr. Pratt very kindly called my attention to the fact that we have another representative of a railroad here. I am indeed glad that the Southern Railway has manifested sufficient interest in this work to send a representative. I cannot, for the life of me, see why any railroad which penetrates any section of country where drainage is so essential as it is in most of eastern North Carolina—I say I cannot see why they should not regard the fostering of this drainage work as one of their greatest achievements.

As I stated, the Southern Railway has a representative here, and it is with great pleasure that I present Mr. Williams, who represents Mr. Harrison of that road.

MR. WILLIAMS: *Mr. President and Gentlemen:* As I told Dr. Pratt when I came here yesterday morning, drainage is something I know very little about, and I have been here listening and learning, and I have found the proceedings very instructive. I do not know that I can say much more. I cannot say anything that would enlighten you who are experienced in the subject, but I just want to say that I am very glad to have been here, and, as you all know, the Southern Railway Company is vitally interested in everything that tends to develop the territory which it traverses. It is in a way a selfish interest, because the business that the company depends upon comes from the development of the territory, but the benefits come first to the people who live in the territory and afterwards to the railroads, in the way of increased traffic. I will say again that I am very glad to have been here, and wish the Drainage Association of North Carolina every success. I would say that the agents of our company are working for farm development in the South, and reports show that they are advising people on that subject, especially in the matter of tile drainage in the drainage of individual farms.

MR. JOHNSON: The object of this Association is not so much to promote the drainage of the individual farms; the primary object of the Convention is to promote an interest in the general drainage of the whole State. About seven or eight years ago I was persuaded to sow some rye in my cotton when I laid it by; the next year I was persuaded to sow some in my hay patches when I cut my pea-vine hay. I just sowed a little, and it did so well that the next year I sowed a great deal more. I saw the success that some one else had attained in this, and I wanted to try it. It is the same way in carrying out the schemes for drainage, and especially for tile drainage. If one man tries it and is successful, then others will see his success, and are apt to take it up.

This Association had been so successful in draining swamp lands that last year we decided to attach another feature to our drainage work. In pursuance of this plan, we elected in Belhaven a Vice President whose duty it was to take charge of this work, and I refer to tile drainage. Even in our swamp-land districts it is becoming more and more apparent that open ditches, that is, lateral ditches, are costly and useless, and it is the purpose of this Association in the future to endeavor to promote an interest throughout the State in tile drainage, and we were fortunate in securing for our Vice President a gentleman who has had large experience in this particular kind of work, and his knowledge of this work is so far superior to mine that I feel it would be superfluous for me to do anything further than to present him, and let him take charge of the Convention this morning. I now take pleasure in presenting Professor M. E. Sherwin, who will preside over this meeting and present the tile drainage work.

GENERAL DISCUSSION RELATING TO DRAINAGE WORK

PROFESSOR M. E. SHERWIN presiding

PROFESSOR SHERWIN: Gentlemen, I am going to forego any maiden Vice Presidential speech—for the good of the whole Association. I want to say a word, though, about the relation of tile drainage, as I see it, to the work of the Association. I had no connection with the Association at the time it was started. In fact, I believe I was not in the State at the time it was started; but when the Association was organized I think the motto taken read: "To promote the drainage of swamp and overflowed lands." Now, that word "drainage" is a broad word, and can have many applications. It should not be limited to district drainage; but in the beginning of the Association the work was necessarily for the drainage of large areas, so that in North Carolina in many sections district drainage necessarily preceded tile drainage. In other words, it was impossible to tile drain, or, as we will say, completely drain individual farms until these larger drainage projects had been fully completed. I do not wish to interfere with the district drainage work, but the time has come when the tile drainage work should take and will take a much more important place as a State-wide movement and as a phase of interest to the Association. I consider that tile drainage is the final drainage of the land, that it necessarily follows district drainage in any section where district drainage is needed. There are sections that require district drainage where tile drainage is important, and probably in every section where drainage is needed tile drainage is needed to complete it, to put, as it were, the final capstone to the drainage work of the State. I hope we will see a great development in tile drainage in this

State, and I hope that this Association will be responsible for the success of this movement, and finally, when the land is drained, that this Association will get the credit, which it will then deserve, for the important work which it has undertaken.

Our program this morning will be very slightly changed from that as printed. The first number on the printed sheet, "Financing of Drainage in Relation to Federal Farm Loan Banks," was discussed by Mr. Camp yesterday morning. His associate in that work, who was also on the program, Mr. Culbreth, is not here; so we will consider that that number was completed in the yesterday morning session. In that connection I would like to call attention very briefly to the Ontario Drainage Law. The Province of Ontario several years ago provided means by which the individual farmers could drain their lands, which is equal in every respect to the Federal Farm Loan Act which was recently enacted by Congress. The point I wish to mention in this regard is the fact that in Ontario the loans run a long time, with privilege of payment at any time, and the actual cost, according to my recollection, is seven dollars and some cents annually for twenty years on each hundred dollars borrowed, making an interest rate, if you figure it down to the interest rate basis, of slightly over 4 per cent. That is probably as good an interest rate as we will ever get under our Federal Farm Loan Act.

Another change in the program will be the moving up of the subject of "Erosion," and this will be the first number on our program this morning. This subject is one of very great importance, as I doubt not the paper will bring out. This paper is by Mr. F. R. Baker of the North Carolina Department of Agriculture.

EROSION AND ITS PREVENTION

(Terracing)

By F. R. BAKER, Drainage Engineer

INTRODUCTION

Ladies and Gentlemen, Members of the North Carolina Drainage Association: The history of our Association is one of progress, adding new subjects from time to time, and I hope to see in the near future departments established to represent the various detail subjects relating to drainage, such as *standard specifications, construction and maintenance, financing, publicity*, etc. Last year we introduced the subject of tile drainage. I am now presenting a new subject, one in which the engineer and farmer have to coöperate in order to produce the best results.

Doubtless, the subject of erosion has not been seriously enough entertained by the engineer; yet much money is expended each year by governments and many engineers are employed to control problems whose existence can be traced to erosion.

Erosion is very active on the hill soils of the South, especially in North Carolina, South Carolina, Georgia, Alabama, Tennessee, and Missouri. Here the soils are generally of a sandy loam, clayey loam, or a sandy-clay nature, underlaid at a depth of 3 or 4 inches by either a stiff red, yellow, or blue clay that is impervious to water.

They are low in humus and are of a fine-grained texture. This together with the rolling nature of the slopes causes these lands to be very susceptible to erosion. In this way the amount of material removed each year is enormous. Probably the rivers of the United States carry over 100,000,000 tons of material each year. It is estimated that during a flood in the James River with a 10-foot crest 300,000 cubic yards of material was carried away in twenty-four hours. Even the rivers of North Carolina carry away some 4,000,000 tons of soil, resulting in a loss of over \$2,000,000 annually to the State.

It should be remembered that while this great amount of soil begins to accumulate on the individual farm, yet it is transported to distant places and deposited, thus involving a study not alone confined to the individual farmer. Hence this problem embodies three features of importance: a national, an engineering, and an agricultural.

ITS NATIONAL FEATURE

While its effects produce a serious national problem, yet the Government at present has very little to do with the control over the causes. Large amounts are expended annually in removing from our streams, reservoirs, and harbors sediment brought down by the rivers. A part of the silt and sand fills the smaller streams and destroys the valley lands. This reduces the run-off and carrying capacity of the streams and is directly the cause of floods that are becoming more frequent and a menace to the safety of our people.

In navigable streams the deposition of silt causes a filling or shifting of the channel and the formation of bars, and navigation becomes hazardous. In some places it is practically impossible to maintain reservoirs, the capacity of which are so reduced that only the flow of the rivers are available for water-power.

In almost every harbor the Government is maintaining dredges that are working incessantly to keep the channels open, little thinking why they have to do it. So it is clearly seen that erosion is truly a national problem, and the State and National governments should lend their energies in promoting methods of prevention and make laws, if necessary, to prohibit indiscreet and careless farming and deforestation.

THE ENGINEERING FEATURE

This then leads to a study of the principles involved in the rate of run-off, transporting power of running water, etc., which can only be intelligently investigated by one grounded in mathematics, experienced in gathering hydraulic data, and competent in deducting plans and formulæ from the data obtained. Clearly, it needs no argument to show the value of an engineer in preparing plans and estimates for building reservoirs, for devising means for keeping them open, for establishing data on hydraulics, and for supervising the operation of dredges in rivers and harbors; yet how often has the

engineer been called upon to experiment with the prevention of erosion, one of the chief causes of most of the trouble?

For many years this problem has been handled exclusively by the farmer, and the results show clearly the need of engineering advice.

What is needed, therefore, is an investigation of the flow of the water from the hillsides, with its control in view, and methods of preventing the movement of silt. It can be clearly seen that erosion is primarily due to the uncontrolled movement of water over an unprotected surface, coupled with the inability of the soil to properly absorb this water. Therefore, anything done to block this movement and promote absorption will lessen erosion. There are many ways of promoting absorption of the soils. Growing cover crops, turning under vegetation and humus, and practicing better methods of cultivation are perhaps the most popular; yet this in itself cannot prevent erosion in climates of heavy precipitation. Something is needed to check the run-off and distribute the flow so that the particles of soil will not be disturbed. Investigations have shown that this can be intelligently done by means of terraces, judiciously designed, to meet local conditions. They are entirely practical and can be used upon the washed lands on any farm and are within the means of the smallest farm operator. They have probably done more in certain sections to better farming conditions than any other single operation, even though their designs have been one of judicious averaging. Its engineering feature has lately been recognized, however, by engineers, and the Office of Public Roads and Rural Engineering has had a drainage engineer working upon this problem who has devised formulæ for their design. These formulæ treat of their cross-section, slope, vertical distance apart and length. With these formulæ properly applied and the terraces properly constructed, the erosion of the hill soils should cease, the migration of soils limited, the discharge into streams governed and made uniform, floods reduced to a minimum, and the need for dredging decreased.

ITS AGRICULTURAL FEATURE

(The Terrace)

Above all, however, ability is needed to properly work out these designs in the field. This, then, introduces an agricultural phase of the subject which includes the construction and methods of cropping.

Terracing is by no means a new subject, because it has been practiced for years in foreign countries. Even in China the preservation of the soils on hill and mountain slopes has only been effected by the use of the terrace.

There are many kinds of terraces in use, but only one that can be adapted to a wide range of conditions will be discussed here. This terrace was originally known as the "Mangum Terrace," but has since developed into the Broad Level and Broad Falling Terraces. Their constructions are the same, but in one case no outlet is provided as is done in the other. The principle of the Falling Terrace is to conduct the water away in a thin sheet with a small velocity, thus lessening its erosive effect and permitting the greater amount of the soil and fertilizers to remain. It is simply constructed but permanent in character, and is adapted to most slopes of less than 15 feet rise in 100 feet.

THE CONSTRUCTION

The construction of this terrace is a feature that determines its efficiency and upon which rests its future popularity.

The mistake heretofore made was to rely upon the eye for location and the plow alone for construction, and the result has been an incomplete, poorly constructed terrace, defeating the purpose for which they were intended. On the other hand, one must equip himself with a simple farm level, a two-horse plow, and a terrace drag.

The outlet where the water from the terraces is to discharge should first be selected. This can be a ditch on the side of the field, a depression, or a body of woods. The terraces should then be staked off with the level by placing small stakes or straws every 25 or 50 feet along the line, allowing a fall, as previously determined, which will not be over 6 inches to each 100 feet toward the outlet. The vertical distance between terraces is governed mainly by the sloping character of the land. This can be accurately determined by applying the formulæ devised. In general, however, it may be said that land with a slope as great as 6 feet in 100 would require a vertical spacing of 4 feet, while where the slope is as great as 15 feet, 5 feet will be required. The length of the terrace is governed by the available outlets, but it is bad practice to make one over 1,200 feet long.

With all the lines thus staked off, begin at the top of the hill with the large plow and follow each line, making all curves easy, and with this furrow as a center line, throw up a back-furrow strip about 10 feet wide. The last furrow should be plowed deep, which will allow better control of the drag. The drag is now run around on the lower and upper sides twice, letting the *hinged* portion follow loosely behind. It is then used with the hinged portion in place. In most soils it may be necessary for the driver to stand on the drag and by moving forward or backward the cutting power can be regulated. At times the tendency of the drag is to cut into the terrace instead of riding it at an angle. This can be regulated by fastening a rope to the end of the hinged portion, which when pulled will lift the drag.

After the terrace has settled it must be plowed again, beginning at the center and adding two or three furrows, as that will be 14 or 16 feet wide, which is wide enough the first year. The drag is then used again as described above, and should always be used after the terrace has been plowed.

If the above operation is done correctly there will be no loss in planting space, no banks to harbor weeds, and the use of the modern labor-saving machinery will be permitted. There will be little loss of fertilizers and soil and needed moisture. The fields will also be made larger and less irregular and the rows can be run in a direction to the best advantage. All of this can be secured at a cost of about 50 cents an acre.

CROPPING TERRACE LAND

Even with a good system of terraces much attention must be given to the methods of cultivation, as the former methods of farming have been closely allied with the causes of erosion. Cotton and corn have met the farming conditions in the South best, due to economic conditions and labor problems.

It has often happened that some land was cropped year after year to these two crops until the soil became so unproductive that its cultivation became

unprofitable. In this way the soil became exhausted of organic matter, and consequently the rains had little trouble in washing large gullies over the surface. This encouraged the cultivation of small areas here and there. Since the introduction of modern methods of cultivation with labor-saving machinery, however, the sentiment has changed in favor of the cultivation of larger areas, as the future use of labor-saving machinery is more or less dependent upon the cultivation of the lands in larger and less irregular bodies. The use of the broad terrace makes this practice possible.

During the first year of cultivation the rows should not cross the terraces, but run practically parallel to them, and the terraces may be utilized by planting them to peas, clovers, oats, or such similar crops. This will not only give revenue, but will give strength to the terraces and keep them from breaking.

The above system of plowing, however, will necessitate short rows. One has stated that it is best to work in two short rows occasionally before finishing, in order to prevent having all the short rows running out together, which would cause too great an accumulation of water at one point. This is the most inconvenient farming operation in connection with the terrace, yet the redeeming feature is that it only lasts during a period of one year. As soon as the terraces have become permanent, the land can be cultivated in any manner most convenient to the owner and the rows run in any direction best suited to local conditions. Yet the usual care should be exercised in crossing a terrace. The plow must be lifted slightly and the furrows filled so that a waterway cannot be started.

Even though the broad terrace can be used under a wide range of conditions, yet the question of adapting crop rotations should be considered before planning terrace systems. It should be remembered that the incorporation of large quantities of organic matter produces an open, porous soil capable of absorbing water, and that deep plowing furnishes a reservoir for the storage of surplus water. This practice to a certain extent should always follow terracing, as terracing alone cannot restore fertility. Yet it is not always best to practice such methods on all crops, so that the tendency to erosion and effects of certain crops must be governing factors in terrace designs. For example, a certain Experiment Station has conducted experiments which indicate that plowing below 8 inches lessens the yield of cotton, and that the quality of tobacco is injured by legume humus, and large quantities of which will tend to produce weedy cotton. When such is the case, sufficient terraces should be incorporated to offset the lack of the above-mentioned practices.

RESULTS

The results from the use of the terrace are becoming general, and can now be seen on almost every farm in Piedmont North Carolina. In no case has there been a dissenting voice in instances where they have been properly used.

One small farmer without any capital came into possession of a worn-out farm. He at first became discouraged to find the gullies getting larger and the land getting poorer generally. He applied for aid, and we gave him a plan that he could follow from time to time. This was two years ago. Not long ago the writer had occasion to visit this farm again, and very little trace of erosion could be found on the sections that had been worked upon. This farmer is now reducing with ease a large mortgage on his farm.

At the State A. and E. College farm at West Raleigh, N. C., there was an eroded field with a gully 6 feet or more deep; but with the aid of terraces this field was made to yield results equal to those on any other portion of the farm. The same is true on all farms where the terrace is introduced. Its advantageous use is recognized as applicable over a wide range of conditions and over a wide territory.

This terrace was introduced about one year ago in Missouri, and reports that have recently come in tell of its successful operation and of its widespread popularity. In that time it has spread from one county to five, and is looked upon as the long-looked-for operation in the development of the washed soils of that State.

Land is one of our indispensable natural resources. It cannot be exhausted like some natural resources, yet it can be so depleted that its usefulness is destroyed. Its continual usefulness is of vital importance to our growing population, and the results of the action of natural and human agencies will determine whether land can be continuously used advantageously for man's purposes or not.

For three centuries slopes not protected have been destroyed, and the natural question is, How will our slopes look after three centuries more of corn and cotton culture?

Public sentiment should, therefore, be awakened to the seriousness of the problem, and the landowner brought to realize the importance of the increasing efforts of control.

Dr. Pratt makes an announcement in regard to an automobile ride for the delegates over the Guilford County roads, also of a visit to the plant of the Pomona Terra-Cotta Company, where tile drain is being made.

PROFESSOR SHERWIN: This country inherited tile drainage probably from England. England was the first country in the world to use farm tile drainage, except probably France. France is credited with having started tile drainage before England, but started it and forgot the art, and therefore does not get credit for it. We have with us this morning an Englishman thoroughly familiar with tile drainage in England and in this country. He is engaged in installing tile drains now. We will be glad to hear from Mr. Harry Cowley on the History of Tile Drainage.

MR. COWLEY: I was called upon by Dr. Pratt to give a little history of tile drainage in England. Of course, this is the first time I have ever been called upon to make a speech. I have been interested in this work ever since I was a boy. When I was a boy, about twelve years, I remember seeing my father drain with a plow drawn by four or six horses. The plow had a share in the shape of a torpedo. They had to dig a main drain along the bottom, and it was made up of brick and slate; roofing slates were fixed on the bottom, bricks put down upon the edge, and roofing slates upon the top. The next method I can understand was to dig the drain and fill it up with all kinds of trash; that gave a great

success for a number of years. The next method that I saw was the slate put on the bottom and the pipe molded in the shape of horse shoes, which was set down on the slate. That gave great success for a number of years. It still kept on improving, until they got to the round tile. In 1892 there was a piece of land on the outskirts of Birmingham. There were about 400 acres which were practically worthless. It was grown up with what they call thistles, as tall as myself, and it was fit for nothing. This 400 acres of land was sold to the Racing Committee. They drained 300 acres of this land, which ran along a hillside. The drains were put in 50 feet apart, 3-inch tile, 2 feet deep. That was to give a good drainage off the race course. In the summer-time they had the water-works laid on. At their notice they could turn on the sprinklers. The drains were to carry off the water. Then for a number of years I was interested in public works on large water mains; so, as I say, I have been interested in public work all my life. I was engaged by this firm to collect water off of about 600 acres of land. As near as I can tell, one hundred years ago this land got into such a state that they had to build ditches to carry off the water. Since I have been in this country I have been working on tile drainage.

PROFESSOR SHERWIN: I should have said in introducing Mr. Cowley that he is engaged in installing the largest system of tile drainage in the State of North Carolina at the present time.

SOME SPECIAL PROBLEMS IN TILE DRAINAGE

By H. M. LYNDE, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture.

Mr. President and Gentlemen: This subject of "Some Special Problems in Tile Drainage" has suggested itself to the speaker by the numerous questions which have come to our attention in our travels over the State of North Carolina in the interest of farm drainage. An attempt will here be made to present these problems, together with their possible solutions, with the feeling that perhaps they may be of assistance to others who may have like problems. Nothing original is offered in the way of solutions; they are simply the results of actual experience of those who have drained, and for this very reason ought to be the more valuable.

All over eastern North Carolina are many farms which have been in cultivation for a great many years, drained only by open ditches. The owners have no doubt many times complained of the expense of cleaning out these open ditches and the hindrance which they cause to farming operations. Perhaps one of them decides that he will try underdrainage. The first problem which presents itself is probably the expense, and whether it will pay to invest money for tile drainage. Last year the speaker presented a paper on "Tile Drainage As An Investment," and attempted to show that underdrainage does pay; but we have here today reports from persons who have tile drained, and the speaker will let them answer that question for you. Assuming, then, that

underdrainage is a profitable investment, what are some of the problems that may present themselves? Stating them briefly and afterwards discussing them, the following have occurred to the speaker as possible problems. These are by no means all the questions that will arise:

1. What kind of underdrain to use.
2. Shall cement or clay tile be used?
3. Is it best to lay tile in old open ditches?
4. How to prevent fine sand or silt from entering the tile.
5. Laying tile through quicksand pockets.
6. How to drain springs and seepage areas.
7. How to drain depressions which have no natural outlet.
8. Will tile become obstructed with roots?
9. How to drain farm premises such as cellars and stockyards.

KIND OF UNDERDRAIN

The landowner has no doubt heard of pole drains, box drains, stone drains, and tile drains. Which shall he use? Pole, box, and stone drains have been used to a considerable extent in the past, and where intelligently applied have given good service while they lasted; but of late years this form of underdrain has been practically abandoned because of their temporary character, usually becoming clogged with dirt in a few years. In clay land with good fall they work very well for a few years, but in sandy or loamy soil they are not satisfactory, because sooner or later the dirt works in between the stones or wood and obstructs the passage of the water. It is practically impossible to get a uniform grade so that pockets will not occur in which silt may collect. Furthermore, you cannot lay out a system of mains and laterals with these types of underdrains. Experience teaches us that they do not give uniformly satisfactory results. Undoubtedly, the best type of underdrain is tile. The difference in the cost of tile is well repaid by the permanence of the improvement, for when put down correctly they need no attention except to see that the outlet is not obstructed.

CLAY OR CEMENT TILE

Clay or cement tile: Which is the better? Which is the cheaper? One of the arguments made in favor of cement tile is that they can be made right on the farm where they are to be used, and that they can be made cheaper than the cost of clay tile. For this reason men are interested in the subject. The answer that we would give to this question is that cement tile, if properly made, are as good as clay tile, but no better. However, they should be made well or not at all, using a good clean sand, and the mixture should not be leaner than one part of cement to three parts of sand, and they should be thoroughly cured. If made properly, there is probably no profit in selling them at prices lower than the current prices of clay tile. If a man can make them in his spare time on the farm, it will probably be cheaper than buying clay tile; but if made at a factory, they cost about the same as clay tile in this State.

TILE IN OLD OPEN DITCHES

On farms covered with old open ditches the question often arises whether it will not be cheaper to lay the tile in the old ditches, thus saving the expense

of digging a new ditch. This again our experience teaches us it is not well to do. These ditches are often crooked, have poor grades, and are filled with several inches of soft sediment. They have been cleared out and deepened so many times that if they are deepened any more the outlet of the tile will be submerged. On the other hand, in endeavoring to secure a good outlet for the tile some of them are laid on soft material and they settle and become clogged. In either case poor results are obtained and in most instances it is better to dig an entirely new ditch. The cost of digging this new ditch will not be so expensive as it may seem, and experienced ditchers prefer this to trying to secure a good bottom in an old ditch.

PREVENTION OF DIRT ENTERING TILE

Where tile are properly laid on a solid bottom, the trench filled immediately afterward, and where there is a good outlet there should be no liability of the tile becoming clogged with silt or sand. In clay or loamy land no other covering than the material taken from the ditch is required. There are occasions, however, where tile are laid in fine or wet sand on a flat grade, where some precautions should be taken to prevent its entrance into the joints between the tile. In such cases a piece of tarred or building paper wrapped around each joint has been found to be satisfactory. This excludes the dirt or sand, but not the water. Of course, the paper may become rotten after a number of years and break to pieces when touched; but after the tile are once covered, there should be no need of disturbing them. After the material over the tile has become established, there is less danger of the dirt working into the joints. In laying tile in fine sand it is probably better to do the work when the soil is dry.

QUICKSAND POCKETS

In digging a trench for tile, small quicksand pockets are often encountered. Water may bubble up from the bottom of the trench for several days after it is opened. In such cases it will be well to wait a few days until the intensity of the flow diminishes. To prevent the tile from sinking or rising out of grade, lay strips of board right on the quicksand at the proper grade, and lay the tiles on these. Wrap pieces of tarred or building paper around the joints and cover with clay. The speaker had occasion to lay some tile through such a formation. The day the trench was opened up a board was laid to grade on the bottom and the tile laid on this board. The trench was left open overnight and the next morning, when examined, the tile had risen about 4 inches above grade, due to the pressure of the water and sand beneath the board. After a couple of days the tile were again set to grade and no more trouble was experienced.

DRAINING SPRINGS AND SEEPAGE AREAS

If the exact location of the spring can be determined, it can best be drained by tapping it directly; otherwise, the supply should be cut off by an intercepting drain. The intercepting system is also used in draining broad, flat areas which are wet because of seepage from the adjoining hillsides. The idea in such cases is to intercept the flow at the base of the hill land. In such cases the line of tile should be laid just above the line where the water comes to the surface. It will generally be found that the soil above the line

of seepage is of a more open nature than that below, the impervious nature of the soil below being the reason why the water comes to the surface.

In general, in laying out a uniform system of drains, the laterals are run in the general direction of the greatest slope. However, in sloping land which is full of springs and seepage areas, and where the soil is not homogenous, it may be better to use the diagonal system, which consists in running the laterals diagonally across the slope. In this way we get the benefits of both the intercepting and down-the-slope systems, the intercepting system cutting off the water before it rises to the surface and the down-the-slope method draining the land on both sides. The objection to the intercepting system alone is that it does not always drain the land on the lower side of the line because it is often lower than the drain.

DRAINAGE OF DEPRESSIONS WHICH HAVE NO NATURAL OUTLET

It is often found necessary to drain saucer-like depressions or ponds with no natural slope except toward the center, where water collects and stands for several days after a heavy rain. Very shallow depressions or those with a more or less open subsoil may be drained by running a line of tile through them and through the ridge to an outlet, to act as a main if laterals are necessary. Some depressions, however, have steep slopes and the subsoil may be of a very tight and impervious nature. The best method to employ in draining such areas is probably to install a surface inlet in the lowest portion to carry off the surface water as fast as it falls. Such a catch-basin consists of a well 18 inches or 2 feet in diameter extending to a distance of about 2 feet below the bottom of the tile and lined with brick, stone, concrete, or sewer tile, and covered with a grating and loose stones to prevent the entrance of trash.

The size of tile leading from the surface inlet will need to be larger than for ordinary soil drainage, since now much surface water is admitted almost as fast as it falls. Whereas, for ordinary soil drainage in this State, the size of tile required is based upon a run-off of one-quarter inch in twenty-four hours; when outside water is admitted to the system, the size of this tile should be so increased as to carry a run-off of 1 inch in twenty-four hours. In other words, if a surface inlet is installed in a depression which contains an area of 5 acres, to find the size of tile needed from the tables computed on a basis of a run-off of one-fourth inch per twenty-four hours, multiply this area by 4, which is 20 acres. Look in the table under the grade on which the tile are laid and find what size is needed to drain 20 acres. As an example, whereas a 4-inch tile on a grade of $2\frac{1}{2}$ inches per 100 feet will drain 5 acres of soil water, yet if surface water is admitted, its size should be increased to 6 inches.

OBSTRUCTIONS BY ROOTS

It is generally conceded that the roots of cultivated plants will not enter a tile that is dry for several weeks in the summer. The reason is that the plants are in search of moisture, and in such cases there is more to be found in the soil than in the tile. It is only when the drains receive water from a spring that runs throughout the year, and in times of extreme drought, when there is a deficiency of moisture in the soil, that there is danger of the roots of certain plants entering the tile. There is generally more danger from the roots of water-loving trees like the poplar, willows, alder, etc., than from

the roots of cultivated plants, and it is not wise to install, too close to these trees, tile which conducts water from a spring. If, however, it is found necessary to conduct water from a spring to a creek bordered by willows, alders, or other water-loving trees, it is best to use pipe with collars and cemented joints where the line passes through the land where these trees are growing. Also, it would be well to cut down the trees for a distance of 25 or 30 feet on each side of the line.

DRAINAGE OF FARM PREMISES

How many times do we see a stockyard so muddy that it is impossible to pass through it without sinking ankle deep in mud? Underdrains through such yards have no effect on them, because the surface becomes so puddled by the tramping of the animals that no water will pass through it to the drains. In such cases it might be well, after laying the drains, to fill the trench with cinders, gravel, sand, or some other porous material, and also cover the entire yard to a foot in depth, with cinders or gravel. The water will then readily reach the drains. The use of surface inlets at favorable points is also recommended.

A wet cellar or a wet foundation to a house is a sure cause of ill-health to its inmates. The whole site on which a house stands should be thoroughly drained. While the speaker realizes that the great majority of houses in the State have no cellars, yet how much more comfortable and healthy would the inmates be with a good dry cellar! Cellars excavated in clay lands are rarely dry without artificial drainage. The effort to prevent water from entering the cellar by cement or concrete walls often fails, and in any event is more expensive than draining. The method best adapted for draining a cellar is to intercept the water before it enters it. A line of tile placed beneath or outside the cellar wall and below the level of the cellar floor will intercept the water and prevent it entering the cellar. The tile should be laid on a slight grade all around the wall and conducted away through a main to a free outlet. By this means cellars can be kept effectively and permanently dry.

If any one present has encountered problems similar to the ones mentioned, or has had other difficulties, I believe we would all like to hear how they were overcome. I thank you.

DISCUSSION

QUESTION: Have you ever been able to find a practical ditcher for the individual farmer?

ANSWER: It depends on how much you have to do. If you have 100,000 feet of tile to lay, it would pay you to get one of these ditching machines.

PROFESSOR SHERWIN: These machines will go through stony land with pretty fair success. My attention has been called to the fact that there are on the table by the window several different bulletins, some by the Department of Agriculture and some by manufacturing companies, all relating to tile drainage.

Last year in the Drainage Convention Mr. Small, whom I think we might call the patron saint of the Association, introduced a resolution

asking the Agricultural Club at the A. and E. College to send a representative to the Annual Convention of this Association. Acting on this suggestion, the Club has sent a man who will give us a short talk on how to lay out a drainage system. This man is Mr. T. Y. Blanton, a student in drainage at the College.

HOW TO LAY OUT A DRAINAGE SYSTEM

By T. Y. BLANTON, Student in State A. and E. College.

Chart No. 1 shows a tile drainage system as laid out on a part of the State A. and E. College farm, West Raleigh, N. C. The field is bounded on the north by one of the roads which run through the farm. On the west it is bounded by an open ditch or gully in which water runs throughout the year. This ditch must be maintained on account of the accumulation of surface water.

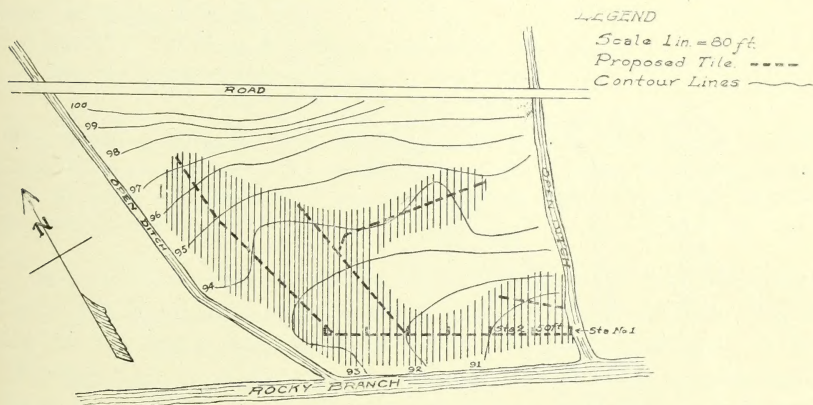


Fig. 1

The water from this ditch enters Rocky Branch, which bounds the field on the south. On the east side of the field is an open dry ditch which must also be maintained on account of surface water. Both the drains have their outlets in this ditch, which carries the water to Rocky Branch. The general slope of the field is from the road to the south toward the branch, except along the branch on the south side and along the ditch on the west side. Here the slope is slightly to the north and east, away from the streams. This condition can be seen by field observation, and the fact is borne out by the contour lines on the chart.

All of this field is cultivated every year and it all produces some crop, but the lower portion does not produce a maximum crop. That this land needs drainage is evidenced by the cloddy and run-together condition of the surface soil. The shaded area on the chart shows the part of the field that needs drainage. The heavy broken lines show the drains as laid out by members of the class in drainage.

The surface of the land is such that two drainage units are necessary. Unit No. 1 consists of a main A with one lateral, and also a submain having one lateral. Unit No. 2 consists of a single line of tile, main B.

Beginning at the outlet (Station 1, Fig. 1), stations 50 feet apart, with extra stations at junctions, were staked out as follows: A short stake, 6 to 12 inches long, was driven down almost flush with the surface, at a point 2 inches from the edge of the proposed ditch. A long stake was then driven down by

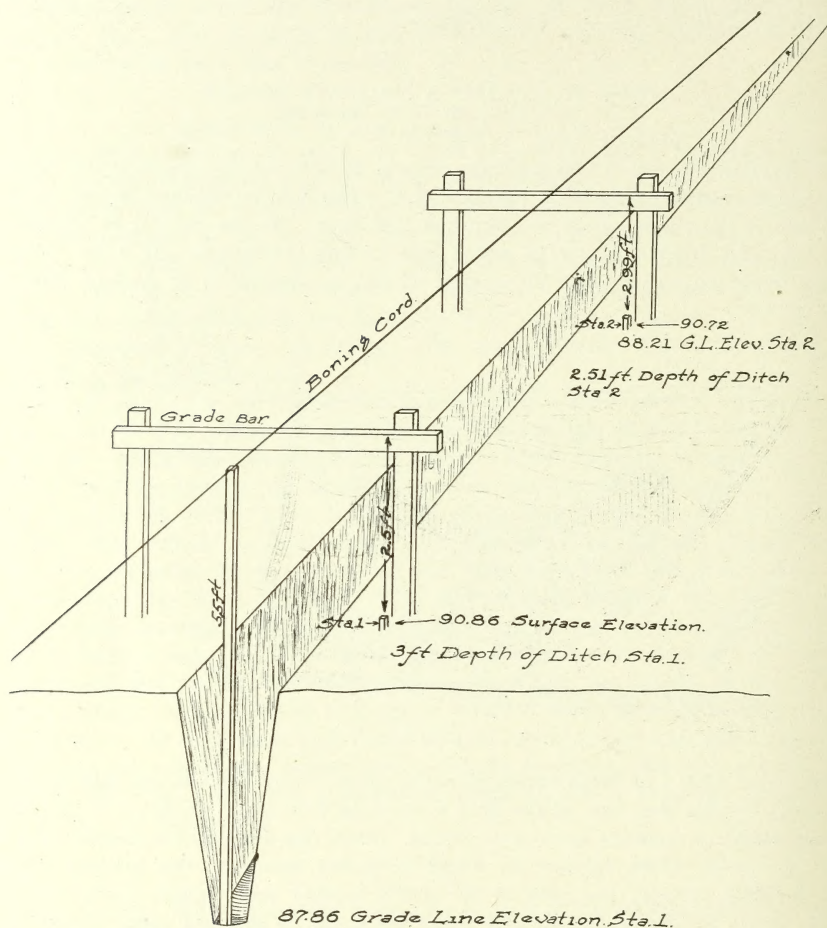


Fig. 2

the side of it. This stake should stand about 3 feet above the surface. It serves as a marker or finder. The short stake is for taking level readings and measurements from.

In laying tile it is necessary to have the grade or fall of ditch uniform, so that the flow of water will not be checked at any point and the tile become filled with silt. Now the surface is irregular, and if the ditch is dug the same depth all the way, the grade will not be uniform. To get a uniform grade we stretch a boning cord just over the center of the proposed ditch. The cord is stretched across grade bars, the height of which is determined as follows: Starting at the outlet, the ditch is to be 3 feet deep. The elevation at this point (Station 1, Fig. 2) is 90.86 feet. Subtracting 3 feet (depth of ditch)

from this, we find that the elevation of the grade line is 87.86 feet. The ditch is to be 3 feet deep at the head also. This elevation is 92.98 feet. Subtracting 3 feet, we find that the elevation of the grade line here is 89.98 feet. Now the difference in elevation at outlet and at the head of the ditch is 2.10 feet, the total fall. Dividing this by the number of 50-foot intervals gives the fall between any two 50-foot stations, which is .35 foot on main A. Adding .35 foot to 87.86 feet (elevation of grade line or bottom of ditch at outlet) gives 88.21 feet. This is the elevation of grade line at Station 2, and is .35 foot higher than the preceding station. Now subtracting grade line elevation of this station (88.21 feet) from the surface elevation (90.72 feet), gives the depth of ditch at Station 2, which is 2.51 feet. The depth of ditch can be found at each succeeding station in the same way.

Since we have found the depth of ditch at each station, we have only to subtract this depth from the length of our boning rod to find how high to place our grade bars above the surface. Thus, if we use a 5.5-foot rod the height of the grade bar will be:

5.5—depth of ditch = height at any station.

5.5—3 feet = 2.5 feet at Station 1.

5.5—2.51 feet = 2.99 feet at Station 2.

The height of all grade bars is found in this way, and the boning cord is stretched across them over the center of the ditch. Then by measuring down from the cord with the 5.5-foot rod all along the ditch, we can tell exactly when we have it to grade.

PROFESSOR SHERWIN: At the end of the current term I shall be obliged to give Mr. Blanton an examination in drainage. I want some of you here this morning to help me to do this by asking him questions.

Tile drainage as an investment has been touched upon at least twice this morning, and I want to emphasize at least one point in that connection. If we take \$25 per acre as an average cost of draining land, what is 6 per cent of that? It is \$1.50 per year. If you consider your tile drainage cost as an investment, you have got to get \$1.50 over your original yield on the land, which we will say is $1\frac{1}{2}$ bushels of corn. Tile drains, wherever used, increase the yields to an extent that is very easily noted—in fact, to an extent that the uninitiated will readily see the value of it. That increase of $1\frac{1}{2}$ bushels of corn, which is necessary to pay interest on the investment, is a very low increase from tile drainage, as any man in the room can tell. In measuring up corn from the field you cannot always tell the difference between 30 and $31\frac{1}{2}$ bushels. You do not notice the difference. I mention this as an illustration that tile drainage does pay very much more than giving us 6 per cent interest on the original investment. We invest in tile drainage because it gives us 60 per cent, or in some cases a great deal more on our investment. In fact, in some cases the increase is infinite, because it brings the profit up from nothing or less than nothing to a good paying crop.

REPORTS OF RESULTS OF USE OF TILE DRAINAGE

PROFESSOR SHERWIN: We had hoped to have here this morning men who could give us written reports on the results of their tile drainage. We have several reports, and I think perhaps there is some one in attendance who has done tile drainage and would favor us with a report.

MR. SCOTT: I have not used tile drainage but a little while, five or six years. I like it very well.

MR. JOHNSON: I cannot speak exactly from personal experience, though I have done some tiling. Referring to the proposition, "Does it pay to drain?" it seems to me you have left out two important features: one, I have not heard any reference to the fact that in maintaining these open ditches you have got to expend annually as much money as these gentlemen calculate is the interest on the money for tile drainage. In the second place, in our country, we figure that about 5 per cent of our total area is appropriated by open ditches and ditch banks. I know some farms where it may run 7 or 8 per cent. There is absolutely no question, to my mind, but what if we could do away with all these open ditches, in ten years we would derive from the land appropriated by these open ditches and ditch banks enough to pay the entire cost of tile draining. There are two problems, however, that arise with us: in the first place, the cost is great, and we have not always been able to raise the money to do it; and, in the second place, our land is so level, with thousands of acres with only an elevation of from 1 to 2 feet, and all of it being only 10 to 16 feet above sea level. It presents a problem that we have not so far been able to meet. In our own farm our rows are 2,650 feet long, and actual surveys of engineers have shown that nowhere in a farm of 300 acres is there an elevation of more than a foot, and our main canal is a mile from the drainage canal, which is something like 4 or 5 feet deep. Now the problem that we have confronting us is just how to cover that whole surface and still bring that water to the canal. Another problem is that after we have this solved for us, where are we going to get competent men to do the work. We can get the engineer and we can get the negro to dig the ditch, but when it comes to laying tile, we cannot find any competent man to do this; so it seems to me that a part of this work, and the work of this Association, lies along this particular line, to interest people who could actually perform the work. It seems to me that in that way we would promote tile drainage more than any other. I know that in my own county there would be thousands or hundreds of thousands of tile drain laid if it could be done by getting a contractor to do the work. I want to say that my brother-in-law owns a farm five miles from Belhaven which was tiled by his father

forty or fifty years ago. There was originally 200 acres in this farm, with one canal running through it. He has no open ditches from his land, and I have never known his property to be injured by water but one time, when a cloudburst occurred and there was an unusual amount of water. He has had occasion when laying some new tile recently to cross some of these older sections, and he found them all in perfect working order. Recently he bought a farm adjoining his, which since my earliest recollection has been nonproductive. While this farm was high enough, and of a sandy nature, yet when the rain came it would all get drowned out. He had to go through a hill that was quicksandy in order to get tile in this field. He took plank and made it four-square, and covered his tile up. He finally got it to hold, and that farm is as productive as any other farm in that section, and I am persuaded that in the past four years it has paid for its tile drain.

Another point I would like to have made clear is this: The National Department and our State Department maintain men in Raleigh for the avowed purpose of helping us in our engineering work, and I think it would be of value to this company if these men would state the exact terms upon which we can obtain this engineering.

PROFESSOR SHERWIN: Mr. Johnson raises two questions: first, with regard to obtaining competent men to do the work of laying tile, and then how to get the services of the drainage engineers at Raleigh. I am going to answer the first question with regard to getting competent men. When you want a thing done well, the thing is to do it yourself; but if you do not feel like doing it yourself, you might raise up boys and train them in the way they ought to go.

MR. BAKER: The best teacher I have seen in North Carolina is Mr. Cowley.

PROFESSOR SHERWIN: I will ask Mr. Lynde to answer Mr. Johnson's other question as regards draining land with very slight fall.

MR. LYNDE: Tile could be laid on a very flat grade if done correctly, and on a solid bottom. Sometimes, for some distance, it is possible to lay tile absolutely level, provided it is not too long a distance; in that case the hydraulic pressure will cause the water to flow through the tiles. The first plan, of course, is to get a good outlet, and if you have a deep ditch, taking the elevation at the upper end and the elevation at the lower end, and work from the lower end toward the upper. The question is asked, What should be the minimum depth of the tile? Of course, 3 feet is about the best depth, but you could do with 2 feet.

In regard to our work in the State: About four years ago the United States Department of Agriculture and the North Carolina Department

of Agriculture formed a coöperative agreement to assist the drainage in the State along practically four lines of work: first, make preliminary examinations of drainage districts for those who desire to make drainage improvements; second, to assist farmers in the terracing of land; third, to assist farmers in tile drainage; and, fourth, to do some experimental work like determining the correct spacing and the water to take care of in a tile drainage system. For the benefit of the private engineers, I want to say that we do not compete with them in giving assistance to farmers. The only thing we do is to try to give assistance to representative farmers in different sections of the State, so that it may serve as an example in interesting other people in the vicinity to take up the same line of work.

QUESTION: If you include the cost of cleaning the ditches at least twice a year, would it not decrease the cost?

PROFESSOR SHERWIN: My recollection is that a paper on that subject was presented a year ago, which is now in press. When that comes out we can all get a mighty good idea of the answer to that question.

HOW TO GET A GRADE FOR TILE DRAINING WITHOUT THE HELP OF AN ENGINEER

By H. COWLEY of Edgecombe County

In Fig. 3 A the line with the letters on it is supposed to be the ground level. First you get a good place for your outlet and then find out the depth you want to put in your tile. Then you put two stakes in A and B, as shown in the figure, and use a parallel rule and carpenter's level and fix A and B exactly level. Hold one boning rod on A and one on B and one on D, then take a

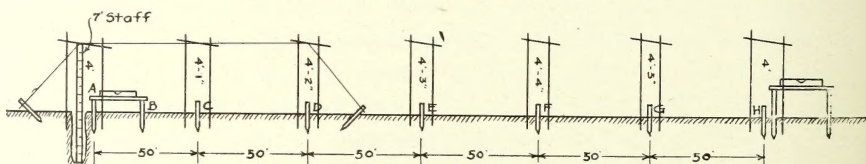


Fig. 3 A.

sight over boning rods on A and B, and drive stake D down till it is exactly level with A and B; or you can fix the one boning rod on stake H and drive it down till it is exactly level with A and B, and then drive down C, D, E, and F till they are all level with A and B. If you want to give it 2 inches fall in 100 feet you could put another stake in 6 inches above stake at H, and take out stake B that is of no more use. I always use a 7-foot staff (B). If you want your drain 3 feet deep, you put up your rail 4 feet at A; 4 feet 1 inch at C; and so on, as shown in the figure, till you get to H. You put that rail up 4 feet above the tallest stake; then if you want to go further on, you fix rule again the same as in the first place.

Fig. 3 B shows the boning rods. They are made 3 feet long, 3 inches wide, and 1 inch thick. The cross-bar is 1 foot long, of the same material; and the parallel rule should be made with $1\frac{1}{2}$ -inch material, width 6 inches, and 12 feet long.

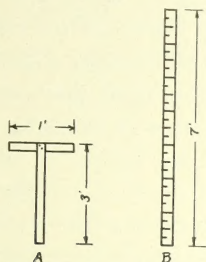


Fig. 3 B.

REPORTS ON TILE DRAINED FIELDS

MR. DODSON: I will just state that I have a piece of land that has two of those soft places in it. It has been absolutely worthless to me. It had never been in cultivation before. About three years ago, in the spring of 1914, we decided to put it in cultivation. I had a barn that was right next to the macadam road, and these depressions were north of that. There were anywhere from six to eight months of the year up to the time when I commenced this drainage project that there was water standing in those pockets. We made a 6-inch drain up into these low places, and where there were some depressions we cut out ditches and put in 3-inch tile. We used in all something over 1,500 feet of tile, and it drained three acres. We did not measure the corn which grew on it the first year, planted on July 4, but it was one of the best pieces of corn I have ever seen. Some of my oldest neighbors said they had never seen a better piece of corn grow. As I said, I did not measure the corn that grew on this land, but we did measure an acre which grew on a piece of adjoining land, which my son raised. On his acre we measured 56 bushels and 46 pounds of corn, as well as I remember. Now, this piece of tile-drained land was far ahead of that. After we took the corn off, we prepared the land and sowed it in wheat, and made 54 bushels of wheat on the three acres. After that we put it in peas and mowed the peas off for hay. I consider that one of the biggest investments I ever made. We ditched it out and made our own tile, cement tile. We had three long ditches; two went to the pockets and another to an upper portion of the land.

MR. E. N. HOLT: Tile drainage is the thing that we need in this country. The land that I have reference to is bottom-land that is very poorly drained. We ran two main drains up through the center

of this land. There were about $1\frac{1}{2}$ acres in the piece. The first year we broke it up we put it in corn, and it grew double what it did the year before. I feel sure it paid us the first year for doing the tile work.

PROFESSOR SHERWIN: Land which needs drainage responds to drainage. I want to quote Professor Thorne of the Ohio Experiment Station. He had been there something like twenty-five years. He said two or three years ago that at the beginning of their work they concluded that tile drainage was of first importance in bringing up the fertility of their lands; that humus and lime were second or third. He was not sure whether the humus was second or third, or the lime, but he was sure at that time that the tile drainage was first in importance, and he said at the end of twenty-five years experience he had seen nothing to change his view.

REPORT ON TILE DRAINAGE

By E. M. DODSON, Greensboro, N. C., R. F. D. 2

The plat here described is located $4\frac{1}{2}$ miles east of Greensboro, N. C., on north side of macadam road leading to Burlington, N. C., and in Guilford County, and contains 3 acres. The shape is as indicated by the attached plate. (Fig. 4.)

The soil is a fine sandy loam, changing to a stiff, sticky gray soil in the lowest parts. The subsoil is lightly streaked with pipe clay in lowest part to a yellow sand-clay formation on higher part.

The lot was considered worthless for agriculture because water was on the surface from six to eight months in the year on the low parts, and was a real mosquito incubator; so it had only been used for cattle pasture up to the spring of 1914. So in January, 1914, we decided to try to put it in cultivation by underdraining it. First we put in three main ditches and two laterals, as indicated by plate, altogether about 1,500 feet of tile 3 inches in diameter and 30 feet of 6-inch tile used at outlet into old ditch. The tile is from 30 to 42 inches deep in the land. We broke the land about 8 inches deep early in the spring with a two-horse turning plow, then disking well, then later re-breaking shallow with one-horse turning plow, then later harrowing again; and on July 3d harrowed with drag harrow, and on July 4th laid off with bull-tongue plow about 42 inches apart and planted with a corn planter 26 inches apart and used 75 pounds 10×4 acid and potash fertilizer per acre. In about five days ran drag harrow over it; the next week harrowed again, then used weeder for a week or two, then used cultivator five times in five weeks. The stand was almost perfect, and our oldest neighbor guessed it to yield all the way from 60 to 75 bushels per acre. Put it in wheat in the fall and made 54 bushels wheat, first quality, in 1915, and put back in wheat again that fall and made 45 bushels in 1916.

To make, the tile cost us about \$20. Ditching and filling cost about \$25. Total for the job, about \$45. Total cost per acre, \$15.

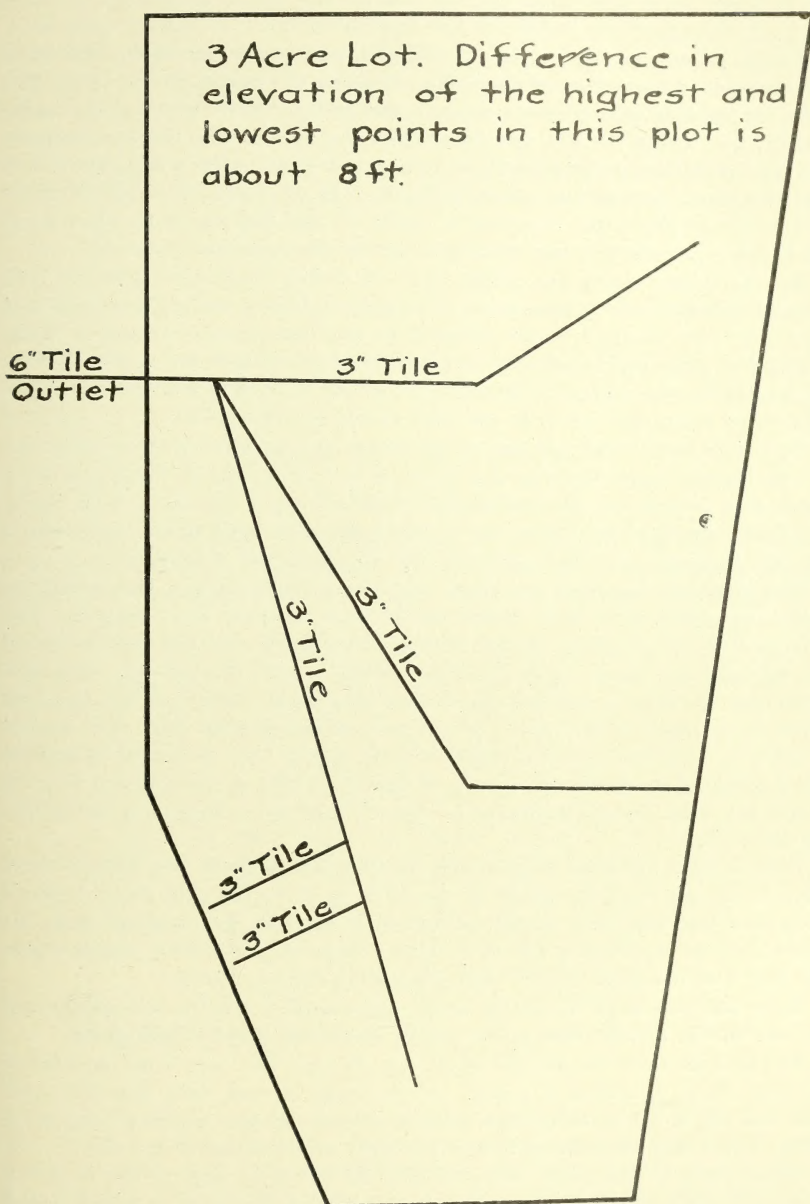


Fig. 4

TILE DRAINAGE*

By A. L. FRENCH, Draper, Caswell County, N. C.

Thirty years ago the writer did his first underdrainage work. The spot drained was a 2-acre "cat swamp" that occupied the center of one of the best fields on the farm where he was raised. The tile cost \$27. The cost of digging the ditches, laying the tile, and back-filling the ditches was not kept account of, for the work was done by the writer at odd spells, after school hours and on Saturdays, during the winter after he was 16 years old. These drains are working today, and mention is made of this first work to show when he began to lay tile and how lasting is the tile-drainage improvement.

Ten years ago there was on our farm in North Carolina a piece of land toward the side of a 30-acre field. The piece (about 4 acres) was underlaid with pipe clay overlaid with a stratum of hard-pan about 4 inches in thickness. The piece was fan-shape. A ditch was dug straight through the lowest portion of the piece 3 feet in depth at the outlet and $2\frac{1}{2}$ feet at the upper end. The outlet is an open ditch on the land owned by a neighbor.

This main drain was dug the entire length and roughly graded before any of the laterals were dug, the clay being of a nature that it would not cave. Then each lateral was dug and graded to the bottom of the main ditch, beginning with those at the upper end of the field. The main drain was close to 40 rods in length, and the upper 20 rods was laid with 4-inch tile.

The work was begun at the upper end, the main being laid fast enough to make connection with each lateral as the ends of these were reached. The ditches were all carefully graded with a tiling scoop, and the connections of the laterals and mains were made by cutting a hole through the main and trimming the ends of the laterals so that they would closely fit the openings made in the main tiles. Small pieces of rock and broken tiles were packed around the connection also, to insure a tight joint. Care was used in grading the bottoms of the ditches to insure as straight a line as possible and an even grade, the latter being determined by the depth of water flowing in the bottom of the ditch.

When a ditch has been finished and the tiles laid, a spade was used to shave off clay enough from the banks of the ditch to cover the tiles about 4 inches deep, and this clay was closely packed over the tiles by tamping; then the balance of the back-filling was done with a team and road drag, except where the clay was the most "pipey," this part being done by hand.

When halfway down the length of the main ditch 5-inch tile was substituted for the 4-inch, to take care of the larger volume of water lower down.

The laterals were run 33 feet apart—as the clay was very stiff—and would average about 30 inches in depth. At the outlet a rock wall was built over the end tile and was built high enough so that surface water during flood-times would flow off either side and not right over the end of the tile.

Three hundred and thirty feet of 5-inch tile cost \$9.90, and the same number of feet of 4-inch cost \$6. Three thousand eight hundred feet of 3-inch lateral cost \$62.95, a total cost for tile of \$78.75. I consider these prices 50 per cent higher than they should be, but they were the best we could do.

The land previous to being drained was worthless, for nothing could be grown on it save swamp grass and poverty grass. Since being drained it

*This plan won the prize of \$10.00.

has been a good average field of the farm, without a ditch to interfere with tools of cultivation, where before deep ditches were used in an effort to do what open ditches will not do for that class of land, and crops have been 40 to 50 bushels of corn per acre, 25 bushels of wheat, $1\frac{1}{2}$ to 2 tons of hay.

No account of the time for doing the work was kept, for it was done during short spells in the winter when other work could not be carried on upon the land.

The whole cost of doing the work—estimated from similar work done on other fields—would probably be around \$35, making the total cost per acre, for tile and work, around \$28.

The first crop of corn grown on the land after the drainage was completed paid around \$30 per acre above cost of growing; so the crops that have been grown since that first year have had to bear no part of the cost of tiling the land.

This is only one of several experiences we have had during the past thirty years in underdraining land, as we do some of the work practically every winter.

REPORT ON TILE DRAINAGE

By I. H. TERRY, Rougemont, N. C.

I have a piece of land containing about six (6) acres in the northern part of Durham County, N. C., in eastern piedmont section. The same is in shape of a D, the outer edge of the round part being elevated about 8 feet, causing

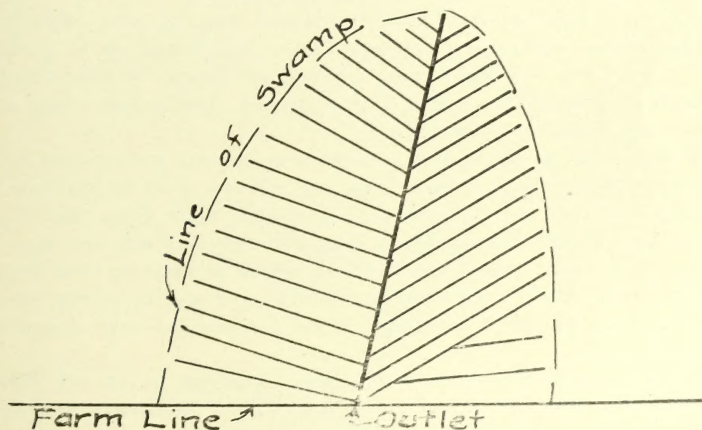


Fig. 5

a basin near center. It is gray soil with variable subsoil, part dark clay and part blue and yellow pipe clay. About twenty-five years ago this was drained almost perfectly with pole underdrain, and part of it yielded 20 barrels of corn per acre; but as pole drain became clogged or choked the yield was decreased till last year it was only about 3 barrels per acre.

As I saw the pole drain was not permanent and was losing two rows of corn by each open drain, I ordered last spring 1,600 feet of hard burned tile from Pomona, N. C., and with the aid of our assistant drainage engineer, Mr. Baker, laid the tile (5-inch main ditch and 4-inch laterals) in the latter part of April.

Owing to the wet spring and summer and the already sodden condition of the land, the yield was increased to only 6 barrels per acre. I know if I had not drained with the tile I would not have gotten a single mature stalk of corn, because my main ditch did not reach far enough up in basin under the knoll and I did not get any stand at that spot.

Have been laying pole drain for twenty years, and I consider, if this tile drain holds indefinitely, as claimed, and drains as it did for me this season, there is no comparison in price. The tile is so very much cheaper. I laid all the tile myself. The labor was \$14 and the tile cost me, freight and all, about \$50. But I know my yield was increased to 12 barrels on the 2 acres in the bottoms; so I consider the tile has just about paid for itself in this one wet season.

Now I feel, as it is permanently drained, I shall be repaid in bringing it back to its former yield of 20 barrels per acre, by cultivating and manuring.

By closing all open ditches, the appearance of this bottom has been improved at least 100 per cent.

RESULTS OF TILE DRAINAGE ON FARM OF T. N. SELLERS,
OF GUILFORD COUNTY

MR. JOSEPH HYDE PRATT,
Chapel Hill, N. C.

DEAR SIR:—In complying with your request of 28th inst., I am sending you herewith something of my experience in tile draining.

I undertook a piece of very wet bottom-land, covered with cat-tails, bulrushes, and alders, and so soft in places that it was dangerous to attempt to cross it. There was a creek flowing through the length of this lowground. The land was higher at the banks of this stream, then became lower as you went from the stream on either side.

I went back from this stream 10 rods or more, cutting a ditch parallel with the creek and then cutting ditches from this into the creek at intervals of 15 rods or more, so that the tiling would not receive more water than it could carry. (I used 3-inch tiling only.) I soon had this land dry and firm. The production of this land since being thus drained is marvelous. The first crop was corn; and by actual measurement this first crop was 15 barrels per acre. Since the soil has become aerated more fully, I expect the next crop to make 20 barrels or more.

I followed that first crop of corn with wheat, disking up the soil when the corn was cut, and sowing 5 pecks of wheat per acre. I harvested 32½ bushels per acre.

Although I was told by the incredulous, when undertaking this work, that "a fool and his money are soon parted," yet I never made an investment that paid bigger dividends, and I never accomplished a work that yielded more lasting benefits.

I have placed nearly 1 mile of tiling, and shall continue till all my wet land is drained. Laying tile is not such a bugaboo as some will tell you, but my advice is to read all the bulletins and all the literature on the subject available; then buy the tools, embark in the work, and you soon become an "old stager," or think you are.

Very respectfully,

T. N. SELLERS.

REPORT ON TILE DRAINAGE

By E. N. HOLT, Greensboro, N. C., R. F. D. 2

1. The area of this drained field is 127,180 square feet, between two hillside fields, with a spring branch zigzagging through the middle.

2. Located between two hills near the McConnell road, a valley about 3 acres long, narrow at places, and wide at others. Dark gray rich bottom soil, with blue clay subsoil.

(a) This bottom in the year of 1911 was an awful thicket, the main ditch, as you will see in the drawing, was grown up in trees from one end to the

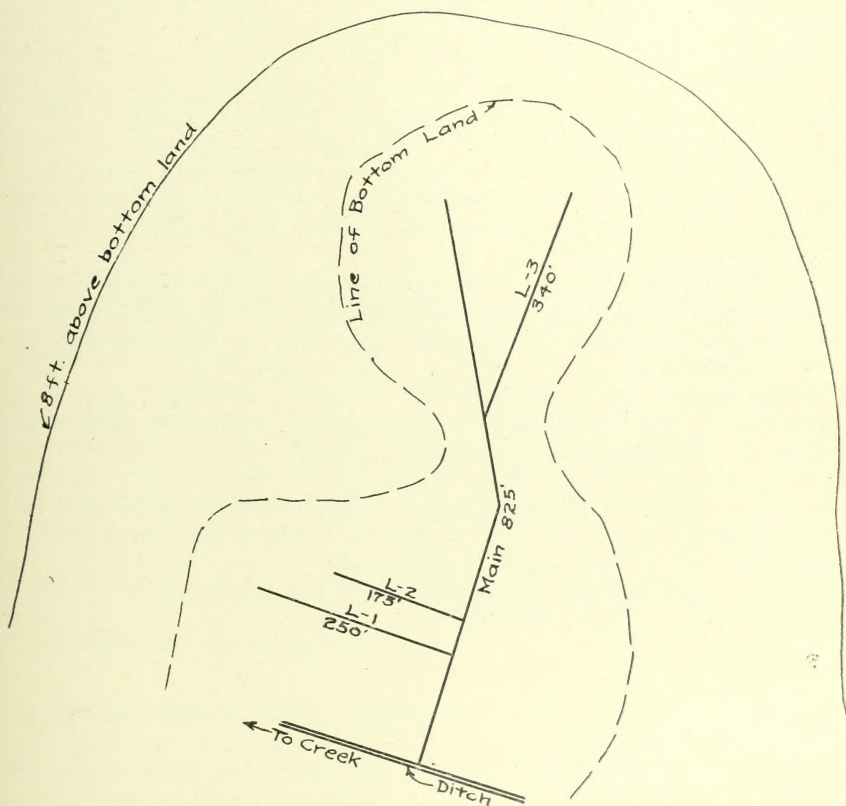


Fig. 6

other; willows, vines, button bushes, had full charge of it. In 1912 it was cleared and ditched; part was ditched before clearing in order to drain out so it could be cleared. In 1913 the ditches were cut and left open to drain until, in the fall of 1913 and the spring of 1914, these ditches were tiled and worked up for corn, which was the first crop cultivated on the bottom. Made an average of 50 to 60 bushels of corn per acre the first year in cultivation.

(b) In 1915 this corn stubble was plowed under in March with a two-horse plow, then seeded down in spring oats, orchard grass, and red clover. The oats reached the height of 2 to 3 feet. Made hay out of the oats which averaged from $1\frac{1}{2}$ to 2 tons of hay per acre. The following fall mowed a ton of clover hay per acre.

(c) In 1916 got two cuttings, and each cutting received a ton per acre; at present a good sod of orchard grass ready for grazing.

(d) Number of tiling laid, 1,043 feet; size of tile, 3 inches. We made our tile out of sand and cement. Cost without sand, labor and cement made our tile come to \$2 per hundred, \$20 per thousand. Cost of ditching, paid 20 cents per rod to have a foot-wide ditch cut, depth not limited. Back-filling was done with day laborers. It will cost from \$25 to \$50 per acre, probably more, to have thoroughly drained.

This report and drawing is very near exact.

JOSEPH HYDE PRATT,

WILMINGTON, N. C., November 9, 1916.

Chapel Hill, N. C.

DEAR SIR:—In regard to your letter of the 2d inst., will say I have about 3 miles of drain tile in my farm; and will say, without it would have to stop farming. I put down 6,000 feet twenty-five years ago of $2\frac{1}{2}$ -inch tile, and later on I used 3-inch altogether.

Tile put down 60 feet apart from 2 to 3 feet deep on ordinary land will be sufficient for good crops. I put my tile in the lowest places where I knew it would be unsafe without. The land I put my tile in was a gray sand on top and a black sand subsoil.

In putting down tile be sure to get a perfect fall. Sometimes I have put it down when I would have to haul water and pour in the trench the tiling scoop left so as to be sure of a perfect fall.

My $2\frac{1}{2}$ -inch tile cost me \$10 per thousand at the factory, and 5 cents per yard to put it down. My 3-inch tile cost \$20 per thousand, and 6 cents per yard to put it down. I can make a satisfactory crop of anything ordinarily, and without tile it would be practically naught.

If there is any more regarding tile I can tell you, will be glad to do so.

Yours very truly,

(Signed) D. G. NORTHROP.

SCOTLAND NECK, N. C., November 12, 1916.

DR. PRATT.

DEAR SIR:—I received a letter from the Agricultural Department asking for a plan on drainage of wet land. We have not had very much of this to do on our farm—only just an acre or so in the bottoms. We had an acre of land that for a good many years didn't make anything. We dug a ditch $1\frac{1}{2}$ feet deep, 18 inches wide, and put fat lightwood stobs crossed in this about every 5 feet apart and put green pine poles split open, one on each side and one in the middle, and wrapped these up with old sacks and burlaps which formed a sifter for the water to drain through, and finished filling this up with dirt. This ditch filled in this way has done good work for the past eight years, and we have made good crops each year on this acre of land and have had no trouble at all. This took one and one-half days work and the output in

money was not anything. This is a good plan for those who have no capital to start with. Tilage in our section costs a great deal of money to start with.

I hope this plan will help some one who has no money to put out in this work. I remain

Your friend,

JOHN SAMUEL HUDSON.

REPORT ON TILE DRAINAGE PROJECT*

By LAWRENCE L. CONNOLLY, Member Boys' Corn Club of Ledger, N. C.

DR. JOSEPH HYDE PRATT,

November 15, 1916.

Chapel Hill, N. C.

DEAR SIR:—Enclosed you will find sketch of a piece of wet land which I wish to drain, using 4-inch drain tile for the work.

The ditch is now almost completed and 400 feet of the tiling has been laid. The whole job will be completed, if weather will permit, in the next few days.

There is about 2 acres in the plat. There is a creek running through a long valley and almost through the middle of the level land. Both sides of the

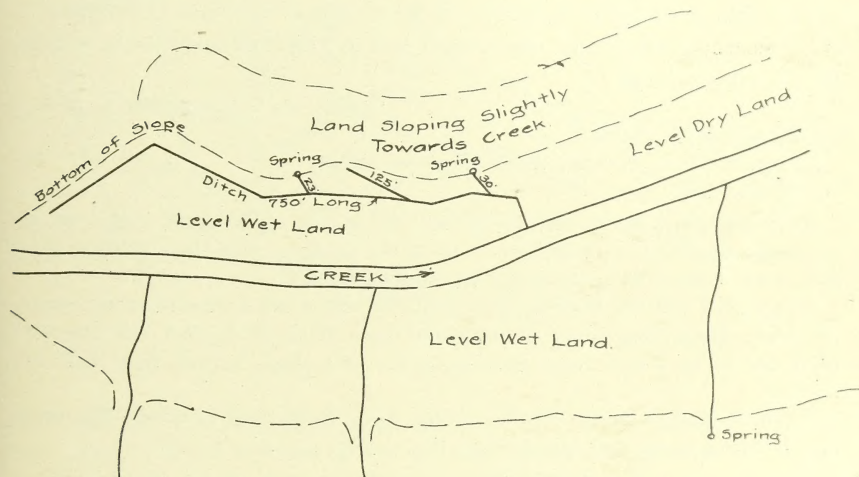


Fig. 7

creek are wet. The water comes from the foot of the hillside, and I am laying the tiling all the way in one continuous ditch, as per sketch, along the foot of the hill.

Soil is settling from the hillside and mountains at the head of the creek. This land is very rich. Has a black loam and pipe clay subsoil.

This land has been too wet to use for anything and has just been grubbed out last spring. Has had no crops grown on it except swamp grass.

The main ditch is 750 feet long, with three small ditches running into same. One of these is 125 feet, one 30 feet, making in all 928 feet.

Am using 4-inch tile costing \$30 per thousand feet. Labor and tiling costing near \$75, or about \$37.50 per acre.

*This plan received the gold medal.

As stated, I have followed a line as near as possible to the hillside and have only one outlet into the creek. I have cut this ditch to the gravel and below in most places, same being on an average of not less than 3 feet deep. Am laying the tiling and at each joint am laying a rock on each side of the joint so that it cannot have any chance to move or get out of its place; then I am taking fine gravel and rock and laying around the tiling to about 2 to 3 inches over the top of same, and then I am taking some of the swamp grass near by and laying some of this on the rock to hold the wet dirt out of the joints of the tiling till same gets to working good. I think that this rock around the tiling will give the water a free access to the tiling and at the same time will keep the ditch from filling too tight around the tiling.

Filling in with rock around the tiling is an idea of my own, and I do not remember any of the farm papers recommending this; but I cannot see why it will not be an advantage to the ditch. Would like to have your idea on this.

I wish to enter this piece of ditch to compete for the gold medal. This is not only giving the plans for doing same, but I am actually doing the work.

The following letter has been received from Lawrence L. Connolly, acknowledging receipt of the medal, and giving further data in regard to his tile drainage:

LEDGER, N. C., December 4, 1916.

DR. JOSEPH HYDE PRATT,

*Secretary North Carolina Drainage Association,
Chapel Hill, N. C.*

DEAR SIR:—I wish to thank you for the award of the gold medal at the Drainage meeting in Greensboro. I certainly do appreciate this, as there must have been some other good plans to compete against.

As stated, I did not have all of this tiling laid when I submitted my report on same. Since then I have finished the main ditch of 750 feet, and the next good day or so I will finish getting in the two small branch lines that are lacking.

I will be glad to report results of this work from time to time. The main line is doing extra well and is carrying a good stream of water.

Yours truly,

(Signed) LAWRENCE L. CONNOLLY,
Member Corn Club.

REPORT ON TILE DRAINAGE PROJECT

By WILLIAM PAGE, JR., Morrisville, N. C., 16 years old.

DESCRIPTION OF FIELD TO BE DRAINED

The field is located on Crabtree Creek near Morrisville, N. C., Wake County. It is a nearly square field, containing approximately 82 acres. It is a flat lowground field, with a dark loam soil, and a clay subsoil, and is nearly level over the entire piece, with the exception of a rise of about 6 inches to 100 feet, and a few low places shown on sketch of field.

The land is used to grow corn at the present time. It makes good corn in a dry year, but in a wet year it is near to a failure, for the corn drowns out.

The field has several ditches that may be removed if the drains were put in as shown in the sketch. The ditches are the only means of natural drainage, and they are not satisfactory in a wet year.

The sketch will be found on a separate sheet, showing present ditches which may be taken out, and the length of each main and each lateral.

The number of feet of tile required for each line are as follows: 500, 400, 375, 375, 125, 150, 175, 225, 200, 200, and 25 yards—2,750 yards in all on the east side of creek. The west system is as follows: 500, 300, 175, 200, 175, 375,

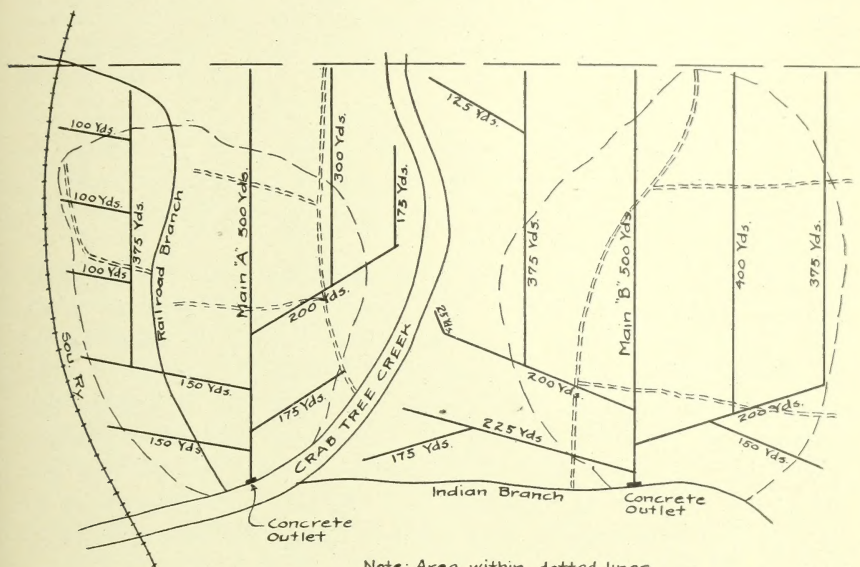


Fig. 8

100, 100, 100, 150, 150 yards—2,325 yards in all. On the west side there is one concrete outlet, and one on the east side, which cost \$5 each.

The cost of the tile is approximately \$25 per 1,000 feet, which makes the tile cost about \$308.

The digging and back-filling of the ditches cost about 9 cents per linear yard, which is about \$45.67. The total cost is as follows:

5,075 yards of 4-inch tile.....	\$ 308.62
Two concrete outlets.....	10.00
Digging and back-filling.....	45.67
Total	\$ 364.29

Cost per acre, \$44.42

REPORT OF COMMITTEE ON TILE DRAINAGE

PROFESSOR SHERWIN: My recollection is that the awards were to have been made by the President. As chairman of the committee on these Tile Drainage Contests, I will make the report. The committee consisted of five besides myself. There was Mr. Lynde, Mr. Baker, Mr. T. E. Brown, and Mr. Cowley, who judged the papers. The papers were nearly all meritorious and the competition was so close that while we did not draw straws to decide it, we might not have done any worse if we had drawn straws for the final decision between the men. The final decision in the men's contest gave the favor to Mr. A. L. French. Mr. French reported everything shipshape and probably with more completeness of detail than any other contestant. It seems rather unfortunate in the face of so close a contest that the sum is not sufficient either to divide or that there are not other prizes to be awarded for second, third, etc., as long as extreme merit lasts.

In the case of the boys' award it was decided to give it to Mr. Lawrence L. Connolly of Ledger. The contest was close here, as in the case of the men's contest. That medal will have to be made up for the occasion; we cannot hand it out today, because it has to be made up, engraved with the name of the person, etc. It is our expectation that these contests are going to develop a considerable interest in drainage among the boys, and probably it is more worth while that the boys' and young men's interest be stimulated than the older men, because of the fact that they have longer to work out their energy and their plans in the draining of land.

MR. T. E. BROWNE: As a representative of the Boys' Agricultural Club work, I want to learn the facts governing this contest. I want to assure the Association that within the next year we are going to call the boys' attention to this. I was especially struck with the knowledge indicated in these papers by the boys. In our meetings and literature we are going to emphasize this work and call their attention to it.

DR. PRATT: I want to make one statement in regard to the papers, that you brought out partly. There were sent out to various persons interested in tile drainage a sheet which stated certain things the report should include, and the judges had to take into consideration whether the papers followed the rules and regulations governing the contest.

MR. JOHNSON: I want to thank our efficient Vice-President for the very instructive and comprehensive session which he has prepared for us, and I want to thank the various speakers for their words of encouragement and instruction. I have been especially impressed with the two papers that have been read in our hearing this morning. I feel that this Convention could well afford to spend not one morning, but

a day or two in the discussion of this very important subject of tile drainage. What we have is certainly good. There is much we can yet learn about this tile drainage, but I do believe and trust that what we have heard this morning will encourage us to study the subject of tile drainage. If each one of us will go home, as a committee of one, resolved that we will try to encourage it in our various communities, in a little while tile drainage will be a reality. While we have had a rather small Convention in numbers, it is gratifying to know that we have 71 persons registered during the two days session. We have 21 counties represented and we have representatives from the States of Georgia, Ohio, and the District of Columbia. There are representatives of the Seaboard Air Line and Southern Railways here. There is one thing that I feel should be mentioned in this Convention. Notwithstanding the fact that we have agricultural papers in our State, designed, as they claim, to improve agricultural conditions throughout the State, looking for subscriptions to men who are interested in agriculture, it is yet a sad fact that there are no representatives of these papers in this Convention, nor, barring the one we have in Raleigh, have I ever seen a representative of an agricultural paper at a drainage Convention. It seems to me that these papers are losing sight of the fact that in ignoring these conventions they are ignoring the strongest factor for agricultural development in our State, and I believe their attention ought to be publicly called to this fact. Therefore I mention it. Next year when this Convention shall meet I hope and I believe that we will have a large representation. I think this year a great many of us who have been charged with the duty of getting the people to attend have rested, in a measure, confident in the belief that if the people would only be so interested, they would come anyhow; but I want to say that next year, if I live, I want to make it my particular business to see that my community is represented more fully than it is this year.

I do not know of any further business that is to come before the Convention at this time, other than the reports of the committees, but since, in a measure, this is an experience meeting, if there is any gentleman present who would like to have something to say, we will be glad to hear from you.

MR. LYNDE: I would suggest that the two tile drainage papers receiving the awards be sent to the editor of the *Progressive Farmer* for publication in his paper.

MR. RANDOLPH: I would like to say to the Convention that while our college (Elon) does not attempt to do more than literary work, yet in our scientific departments we are especially interested in agriculture and in giving our boys and girls a fundamental idea of its

principles. I have been very much interested in the sessions of this Convention and have gained some ideas which I would like to take back with me.

QUESTION: I would like to ask one question, and that is how we are going to get labor to carry out this drainage work, and also to carry on the farm operations after the land is drained.

MR. JOHNSON: In our immediate section the land is so fruitful when cleared that we are justified in paying large sums for contract work, and any negro who will half work can earn \$2 per day for an eight-hour day. This fact has become more generally known throughout the eastern sections, and for this reason we have a great deal of negro labor; but it is only fair to state that in drawing on this labor from other sections it is not treating those sections exactly fair. So far, the foreign labor has been extremely unsatisfactory. We have had some Russians and Poles and a scattering of other nationalities. In nearly every case they were dissatisfied. This labor problem is one that no one has as yet found a solution for. To give you some idea of about what it costs to develop an acre of land, we pay \$8 per acre for cutting down, \$5 per acre for the lateral ditches, perhaps \$1.25 to \$1.50 to stick the corn. It will cost perhaps \$2 to cut the weeds in it one time. That embraces all the work. It will cost 50 cents per barrel on the average to raise the corn. The land will average anywhere from eight to twelve to fifteen barrels per acre, and we have not sold any of that corn for less than 80 cents per bushel. You can readily see, if you take an acre on which you have invested, say \$25, and you can sell all the crop off of it for \$50 per acre, what it means. Would it not be a good plan to cut these large farms into small farms, and induce the people of the west to come there instead of going to Canada? Land now sells for \$30 per acre uncut, that is, with the wood still on it.

REPORTS OF COMMITTEES

REPORT OF COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report as follows:

Place for next meeting—Lumberton, Robeson County, N. C. That a mid-winter meeting be held in Raleigh, N. C., the dates to be decided on by the Secretary.

For President—Professor M. E. Sherwin, of Wake County.

For Secretary-Treasurer—Dr. Joseph Hyde Pratt, of Orange County.

For First Vice-President in Charge of District Drainage—D. B. McNeill, of Robeson County.

For First Vice-President in Charge of Farm Drainage—H. M. Lynde, of Wake County.

For Second Vice-Presidents—E. Oscar Randolph, Alamance County; P. H. Johnson, Beaufort County; O. L. Clark, Bladen County; H. B. Craven, Buncombe County; J. A. Scott, Cabarrus County; R. L. Rockett, Catawba County; J. A. Brown, Columbus County; W. F. Aberly, Craven County; Hersey Everett, Cumberland County; Bennehan Cameron, Durham County; H. Cowley, Edgecombe County; N. L. Cranford, Forsyth County; W. C. Boren, Guilford County; Dr. C. A. Statesbury, Hyde County; Lovit Hines, Lenoir County; W. D. Alexander, Mecklenburg County; J. L. Becton, New Hanover County; Miss H. M. Berry, Orange County; W. A. Brown, Pender County; Bruce Craven, Randolph County; J. B. Sellers, Robeson County; V. T. Baggett, Sampson County; C. Bodenheimer, Stokes County; F. R. Baker, Wake County; J. H. Stallings, Wayne County.

Vice-Presidents from other counties are to be named by the Secretary-Treasurer.

MR. SELLERS: I move that the Secretary be instructed to cast the entire vote of this Convention for the officers as given by this Nominating Committee.

Motion carried.

REPORT OF COMMITTEE ON RESOLUTIONS

The North Carolina Drainage Association, in annual session in the city of Greensboro, North Carolina, submits the following declaration and resolutions in behalf of the public activities to which it is committed. This Association was organized in the city of New Bern in 1908 for the purpose of promoting the reclamation and more efficient drainage of wet and overflowed lands in the State. As a result of the coöperative efforts of this Association, a modern drainage law was drafted and enacted into law by the General Assembly of the State at its session of 1909. Under this law as amended from time to time many drainage districts have been established, many thousands of acres of wet and overflowed lands have been reclaimed, and many other thousands of acres of lands which were subject to occasional overflow and consequent damage to growing crops have been efficiently drained; and all these lands are now in a productive condition. The net results of these activities represent an increment to the wealth of the State estimated by some as high as \$50,000,000, thereby increasing the revenues of the State and counties and multiplying the volume and value of farm products and contributing to the welfare and prosperity of the people.

We urge upon the intelligent and progressive citizenship of the State a continued interest in the work of the Association, particularly by attending its sessions and participating in the educational processes intended to extend the benefits of drainage to every locality.

We commend to the Legislature of the State due consideration of the importance of maintaining a wise and workable drainage law, and we express the hope that certain amendments which will be proposed to the Legislature at the coming session of 1917 will be promptly enacted into law. To this end we urge the Association at this meeting to authorize and direct the Legislative Committee to hold a meeting in the city of Raleigh during the coming session of the Legislature at such time as may be designated by the President

and Secretary of the Association for the purpose of presenting to the appropriate legislative committees the necessity for these amendments and their enactment without material change.

That the President and Secretary of the Association be requested to exercise unusual efforts by way of publicity and correspondence to secure a large and representative attendance of citizens at the next annual meeting of the Association.

That this Association extends cordial thanks for many courtesies extended in preparation for and during the sessions of this Convention in the city of Greensboro. We especially thank the Chamber of Commerce for its coöperation, the Board of County Commissioners for the use of the courthouse for the sessions of the Convention; the press of the city for their generous reports of the proceedings; the Manufacturers' Club for courtesies extended; and all those citizens of the city of Greensboro who have participated in welcoming us and in making our stay so agreeable.

JOHN H. SMALL, *Chairman*,
 BENNEHAN CAMERON, Durham County,
 W. C. BOREN, Guilford County,
 E. WILLIAMSON, Sampson County,
 W. F. ABERLEY, Craven County,
 J. A. WILKINSON, Beaufort County,
 N. L. CRANFORD, Forsyth County,
 A. E. HIRE, Forsyth County,
 G. B. SELLERS, Robeson County,
 JAMES SLATE, Stokes County,
 BRUCE CRAVEN, Randolph County,
Committee on Resolutions.

The report of the committee was accepted and the resolutions as presented were unanimously adopted by the Convention.

RESOLUTIONS OF SYMPATHY

At the Eighth Convention, held at Belhaven, a resolution of sympathy was sent to Mrs. B. E. Rice, on the death of her husband, one of our most valued members. The following letter was received from Mrs. Rice in reply:

MR. JOSEPH HYDE PRATT,
Chapel Hill, N. C.

WENONA, N. C., January 24, 1916.

DEAR SIR:—Your note of December 22d was received by me some time ago, also the copy of resolutions adopted by the Drainage Convention. The sentiment expressed in the resolutions was greatly appreciated by myself and family. Also I wish to thank you for your kind expressions of appreciation of my dear husband's work. Your kind words are very comforting.

Again thanking you, I am,

Very sincerely,

(Signed) MRS. B. E. RICE.

On the death of Mr. William Milholland, the following resolution was passed, and forwarded to Mrs. Milholland of Norfolk, Va.

RESOLUTION

Resolved, That this Association expresses its deep regret at the death of our esteemed former member, Mr. William Milholland, and its appreciation of his faithful work in coöperating with our Association in the development of the State; and the Secretary is herewith requested to extend the condolences of this Association to the bereaved family.

REPORT OF MEMBERSHIP COMMITTEE

The Membership Committee reported a total registration of 71 from the following 21 counties:

Alamance, Beaufort, Buncombe, Cabarrus, Craven, Catawba, Durham, Edgecombe, Forsyth, Guilford, Hyde, Lenior, Mecklenburg, New Hanover, Orange, Randolph, Robeson, Rowan, Sampson, Stokes, and Wake.

There were also representatives from Georgia, Ohio, and Washington, D. C.

A complete list of the registration is given at the end of the proceedings.

MR. JOHNSON: I would like now to turn over the Convention to its next President, Professor M. E. Sherwin of Wake County.

MR. SHERWIN: I thank the Association very heartily for this honor, but I will forego any presidential address, the same as I did the vice-presidential address.

The Convention adjourned *sine die*.

DELEGATES WHO REGISTERED AT DRAINAGE CONVENTION, GREENSBORO, N. C. NOVEMBER 22 AND 23, 1916

<i>Name</i>	<i>Town</i>	<i>County</i>
W. F. Aberly.....	New Bern	Craven
Will D. Alexander.....	Charlotte	Mecklenburg
Eugene Baggett	Salemburg	Sampson
V. T. Baggett.....	Salemburg	Sampson
F. R. Baker.....	Raleigh	Wake
J. L. Becton.....	Wilmington	New Hanover
H. M. Berry.....	Chapel Hill	Orange
J. B. Blades.....	New Bern	Craven
T. Y. Blanton.....	West Raleigh	Wake
W. C. Boren.....	Pomona	Guilford
D. Tucker Brown.....	Chapel Hill	Orange
T. E. Browne.....	Raleigh	Wake
W. S. Bullard.....	Roseboro	Sampson
Bennehan Cameron	Stagville	Durham
Wm. R. Camp.....	Raleigh	Wake
J. H. Clinard.....	Winston-Salem	Forsyth
A. Wayland Cooke.....	Greensboro	Guilford
H. Cowley	Tarboro	Edgecombe
N. L. Cranford.....	Winston-Salem	Forsyth
Bruce Craven	Trinity	Randolph
H. B. Craven.....	Ridgecrest	Buncombe
P. H. Cranford.....	Greensboro	Guilford
Cheater Dodson	Greensboro	Guilford
E. M. Dodson.....	Greensboro	Guilford
J. C. Forrester.....	Greensboro	Guilford
Cyrus P. Frazier.....	Greensboro	Guilford
D. L. Fullerton, The Tillotson & Wolcott Co.....		Cleveland, Ohio
W. F. Goodman.....	Concord	Cabarrus
J. R. Hardin.....	Greensboro	Guilford
Lovit Hines	Kinston	Lenoir
E. N. Holt.....	Greensboro	Guilford
Jos. A. Hoskins.....	Summerfield	Guilford
E. E. Hunter (S. A. L. Ry.)..	Wilmington	New Hanover
C. H. Jessup.....	Peters Creek	Stokes
P. H. Johnson.....	Pantego	Beaufort
Wm. M. Jones, M.D.....	Greensboro	Guilford
A. W. Jordan.....	Greensboro	Guilford
Andrew Joyner	Greensboro	Guilford
H. M. Lynde.....	Raleigh	Wake
Rory McNair	Maxton	Robeson
D. B. McNeill.....	Lumberton	Robeson

<i>Name</i>	<i>Town</i>	<i>County</i>
R. J. Mebane.....	Greensboro	Guilford
S. A. Miller.....	Winston-Salem	Forsyth
W. E. Miller (P. O. Box 232) ..	Greensboro	Guilford
L. Moseley	Greensboro	Guilford
W. S. Needham.....	Barber	Rowan
R. E. Parker.....	Raleigh	Wake
Joseph Hyde Pratt.....	Chapel Hill	Orange
E. Oscar Randolph.....	Elon College	Alamance
W. A. Reynolds.....	Winston-Salem	Forsyth
Otis M. Rockett.....	Greensboro	Guilford
R. L. Rockett.....	Conover	Catawba
J. A. Scott.....	Concord	Cabarrus
Howard See .....	.....	Atlanta, Ga.
G. B. Sellers.....	Maxton	Robeson
J. B. Sellers.....	Maxton	Robeson
T. N. Sellers.....	Brown Summit	Guilford
M. E. Sherwin.....	West Raleigh	Wake
James W. Slate.....	Mizpah	Stokes
John H. Small.....	Washington	Beaufort
W. B. Stafford.....	Winston-Salem	Forsyth
C. A. Statesbury.....	New Holland	Hyde
M. W. Thompson	Greensboro	Guilford
John D. Waldrop.....	Greensboro	Guilford
M. C. Henley.....	Greensboro	Guilford
J. C. Williams (South'n Ry.) ..	.....	Washington, D. C.
Arthur Williamson	Salemburg	Sampson
E. Williamson	Salemburg	Sampson
Hiram B. Worth.....	Greensboro	Guilford
W. H. Worth.....	Greensboro	Guilford

PRESS NOTICES

Since the drainage meeting in November, 1916, the following press notices have been prepared and sent to the press:

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FORESTRY DIVISION

Press Notice No. 42.

CHAPEL HILL, N. C., November 25, 1916.

DRAINAGE DISTRICTS AND FOREST FIRE PREVENTION

At the Drainage Convention just closed at Greensboro, Dr. Joseph Hyde Pratt, Secretary, brought out in a short talk the fact that enforcement of the State Forest Fire Law is of primary importance to those who are interested in drainage districts. As, however, swamp lands are not generally considered very susceptible to fire, the connection may not at first sight be obvious.

The establishment of drainage districts means the making available for agriculture of large areas of swamp land and the necessary throwing upon the market of large quantities of swamp timber. In Eastern North Carolina probably 90 per cent of such timber is gum, for which, even though much is now cut for lumber and veneer, there is as yet but a limited market. The recent demand for timber for paper pulp throughout North Carolina is opening up another and very important market for gum timber, and, as small sizes are just as valuable as the large timber for this purpose, this use for gum will soon become general and undoubtedly very profitable.

Capital is now seeking investments in North Carolina gum lands, with the object of locating pulp mills here. The State Geological and Economic Survey has on file a number of letters from different parts of the country inquiring about suitable sites for such mills. That the interest is real can be seen from the fact that two exhibits of pulpwood were made at the State Fair: one by the Belhaven Board of Trade and the other by parties who are endeavoring to bring a pulp mill to Wilmington. The journal, *Paper*, the official organ of the Technical Association of Pulp and Paper Industry, also sent an exhibit, which unfortunately arrived too late to be shown.

The manufacturing of pulp requires a very large investment, and capitalists are unwilling to locate a mill where there is not a good prospect of a permanent supply of timber. Swamp land which is to be drained and become agricultural land may be able to supply mature timber for a number of years, but the supply will run out; so that some other source of supply is necessary. This may be found in the poorer pine lands of the region—those which have been cut over and are now, owing to the frequently recurring fires, almost bare of young growth. Were fires prevented a crop of pine would soon cover such lands and a perpetual supply of pulpwood timber would thus become available in from twenty to thirty years. Some pulp mills desire to purchase such lands in order to be assured of their supply; while others are content to know that near-by landowners are preparing to supply their permanent

demands. Fires in Eastern North Carolina have destroyed and are still destroying the greater part of the young pine growth, but as soon as this can be prevented these poorer lands can be made to pay well in the production of pulpwood. It is only where the assurance of such a permanent supply can be secured that pulp mills can be established, and, for this reason, it is very greatly to the interest of all owners of swamp timber to see that the near-by pine lands are protected from fire.

North Carolina already has a Forest Fire Law which, if enforced, would go a long way towards furnishing adequate protection. All that is needed is an appropriation to put it in force. The next General Assembly will be asked for such an appropriation, and it is confidently hoped that such may be secured.

TILE IN FARM LAND DRAINING*

The farmers of the South are beginning to realize that tile drainage of their farms, when this is done in the proper way, increases very materially the productiveness of their land. This interest has been quickened to such an extent that the demand for tile drainage for farms is very greatly in excess of the number of men who are capable and competent of laying tile to take care of the work. There are a few men in the South who are experts in farm-land draining. I mean by this that they are experienced and competent in the actual laying of the tile so that it will be able to accomplish the work that is expected of it. Tile draining of farm land has in many instances been declared unsuccessful and of no value, and in practically every case it has been due to the fact that the tile was not properly laid. Many farmers, who know that tile draining for farm land is of an advantage to most land, have decided to thus drain their farms, have sent to the factories and bought the tile and then, without any previous experience, have started to lay the tile, and in most cases failure has resulted. In other cases the farmers have taken the precaution to have an engineer lay off a scheme for the tile draining, and then have attempted to lay the tile themselves; and again in many instances the work has been a failure. It needs experienced men to lay the tile just as much as it is necessary that a plan for the tile drainage shall be worked out and a line for the tile be staked out.

I believe the best way to overcome this is for the different States to appoint a Tile Demonstrator, under the Department of Agriculture, whose business shall be to give instructions in the various communities how to lay tile, and the instructions should be given by actual work in laying tile. I believe there are hundreds of thousands of feet of tile to be laid in North Carolina if competent men could be obtained to do the work, and the farmers could be assured that their tile would be laid in the right way.

DRAINAGE CONVENTION

RALEIGH, N. C., February 1, 1917.

In connection with the Drainage Convention that will be held in Raleigh on Thursday, February 1, there will be given in the City Auditorium at 8 o'clock Thursday night an illustrated lecture on what has been accomplished by drainage under the North Carolina Drainage Law in North Carolina during

*Published in *Manufacturers' Record*, February, 1917.

the past few years. This lecture is free, and all who are interested or wish to know something about the swamps of North Carolina are cordially invited to attend. There will be about one hundred pictures shown of the various steps in drainage, and of scenes in the swamps and of the land after it has been drained and cultivated. This is the first time the people of Raleigh have had an opportunity of seeing illustrations of what drainage has accomplished in this State. There will also be a meeting at 3 p. m. in the rooms of the Chamber of Commerce, when the North Carolina Drainage Law will be discussed.

The public is cordially invited to come to the illustrated lecture and see how the North Carolina Drainage Law has increased the wealth of the State by at least \$50,000,000.

MIDWINTER MEETING

OF THE

NORTH CAROLINA DRAINAGE ASSOCIATION

On Tuesday, February 1, 1917, the North Carolina Drainage Association held its Midwinter Meeting at Raleigh, N. C. This meeting was called largely to take up the discussion of the needed amendments to the North Carolina Drainage Law, and also to give information to the members of the General Assembly, and others interested, as to what had been accomplished by reason of the North Carolina Drainage Law.

Among the proposed amendments discussed at the meeting were:

Providing for paying the expense of a preliminary survey;

For a more equitable classification of the land of the drainage districts;

A provision in regard to transfer of land in the districts so that the assessment rolls be made to conform with the present owners of the land;

A provision relating to the election and term of office of the commissioners of a drainage district; length of the term of office, appointment of successors, and what remuneration should be allowed;

A provision relating to the acceptance by the State Treasury of drainage bonds to be deposited by banks, insurance companies, etc.;

A provision authorizing the formation of subdistricts within main districts for the purpose of securing tile drainage;

A provision in regard to the naming of districts, that a district shall be named from the county in which the greater portion of the district is located, together with a number indicating the number of districts in the county; as, for instance, the eight districts of Mecklenburg would be named "Mecklenburg County District, No. 1, 2, 3, 4, 5, 6, 7, and 8."

A provision relating to increasing the number of payments permitted in paying off drainage bonds.

The night session consisted of illustrated lectures on what had been accomplished in the drainage of the swamp lands of Eastern North Carolina. These lectures were given in the City Auditorium, and were well attended by members of the Legislature and others.

The first talk was given by Joseph Hyde Pratt on "What Has Been Accomplished by Drainage." He stated briefly as follows:

"Up to the present time there have been organized 123 drainage districts, 38 of which have been fully organized and the drainage completed; 20 have been completely organized and the drainage work is now being done; 42 are still in process of organization; 11 have been organized, but for one reason or another the work has not started on the ditching and canals; and 12 have been abandoned. Through this work approximately 850,000 acres of swamp land have been reclaimed, and 100,000 acres of overflowed land in Piedmont and Western North Carolina. It is estimated that the cost of draining the swamp land varies from \$4 to \$6 per acre; and for the drainage of the overflowed land in Piedmont and Western North Carolina the cost varies from

\$15 to \$25 or more per acre. The reclamation of these lands means that land which was formerly bringing in no revenue to its owner and was a menace from the standpoint of health is now producing from 40 to 100 bushels of corn per acre, from 1 to 2 bales of cotton, and other crops in like proportion. This reclaimed land, in fact, is the most productive and richest in the State, and will produce in abundance any crop which can be grown in this climate. When it is realized that the taxable value of this land before being drained was from 25 cents to \$1 per acre, that it costs from \$19 to \$31 per acre to drain and clear it, and that after this is done it can be sold at from \$50 to \$150 per acre, some idea can be gained of the tremendous import to the State of draining approximately 800,000 acres of swamp and overflowed land. A conservative estimate of the agricultural value to the people of North Carolina through this drainage work is \$50,000,000, without even taking into consideration the gain from the standpoint of health.

"Cattle raising should and will become a very important industry in Eastern North Carolina just as soon as a stock law is enforced throughout that section of the State. It will be impossible to develop the cattle industry without a stock law. Already the State has lost considerable capital which was ready to invest in large acreage of land upon which to raise cattle. In some instances negotiations were all ready to be closed for the land when it was found that the section in which the land was located had no stock law, and the negotiations were called off. As one cattle raiser expressed it who was contemplating purchasing a large acreage in Hyde County: 'There is no sense in my bringing into Hyde County valuable cattle and raising them when there is no chance of shipping them out.'"

The next speech was by Mr. Willard T. Kyzer, Agricultural Agent of the Norfolk and Southern Railroad, who gave a splendid talk on "The Reclaimed Swamp Lands of Eastern North Carolina." His talk was thoroughly illustrated with splendid views, illustrating the various steps of reclamation of these lands and of the crops that have been and can be raised upon these reclaimed lands.

The last speech was by Mr. D. N. Graves, of Boston, President of the New Holland Farms Company. He gave a most comprehensive and enjoyable talk on the Lake Mattamuskeet District. His pictures showed the various steps in the reclamation of this district.

SUGGESTED LEGISLATION*

In connection with the work of the Legislative Committee of the North Carolina Drainage Association, letters were written to the various bond dealers and others in regard to suggestions as to amendments to the Drainage Law. Letters were received as follows:

LUMBERTON, N. C., January 22, 1917.

DR. JOSEPH HYDE PRATT,
Secretary N. C. Drainage Association,
Chapel Hill, N. C.

DEAR SIR:—Yours of the 20th, *in re* changes in the North Carolina Drainage Laws, at hand, and in reply will say that while I am in full sympathy with any betterment of the Drainage Laws, I hardly think it probable that I will be able to attend the proposed meeting at Raleigh.

Last August, while surveying in the sand hills in Scotland County, I was infected with poison sumach, with disastrous results. I have been laid up since the first of September. Early in December I went to Baltimore for treatment, returning last week, and while I am much improved, I will not be able to get about much before March.

I am greatly interested in the proposed amendments, and should very much like to have a copy of the proposed changes. I might be able to offer some suggestion from my experience here and elsewhere that would be useful.

One thing that would be of help would be some plan whereby one or more of the men who have acted as viewer or commissioner in any district should be available to new districts. In their work they have gained practical experience that is invaluable, and that under the present system is wasted. A viewer or commissioner who has acted for one district has acquired an experience and working knowledge of details and of the laws that will enable him to avoid the delays and blunders that an entirely new set of men will be likely to have. A better way would be to have one commissioner and viewer act for the entire county in all drainage matters, and the other two possibly selected as they now are. That way would insure one experienced member at all times.

I think that Section 31, as amended in 1911, is still susceptible of great improvement. In fact, it is practically impossible to comply with the provisions of Sections 3, 32, and 34, as they are conflicting. Besides that, to at once compute the entire assessment roll for the full ten years entails needless work and expense, for at that time no one knows who or how many will pay at once or how many will let their land be taxed for the bond issue, and the computations made for those parties paying at the outset is time and money thrown away.

The complete assessment roll for the ten years should not be made until *after* the expiration of the fifteen days allowed to pay cash and save the extra

*The amendments to the North Carolina Drainage Law passed by the General Assembly of 1917 are given in Press Bulletin No. 158 of the publications of the Survey.

expense of the bond issue. To be clear and unassailable, those three sections should be rewritten and rearranged. It would not be a difficult matter to so arrange them that there would be no chance to misconstrue the provisions of these sections, and so they would not conflict.

I will do what I can with Senator Gough and Representatives Sellers and Oliver; but to talk to them intelligently I should have a copy of the proposed changes and amendments.

Very respectfully yours,

(Signed) F. F. WETMORE.

GEORGE S. SPEER & CO.

MUNICIPAL AND CORPORATION BONDS

10 South LaSalle Street

CHICAGO, ILL., January 27, 1917.

HON. JOSEPH HYDE PRATT,
Secretary Drainage Association,
Raleigh, N. C.

DEAR MR. PRATT:—From the *Manufacturers' Record* and other sources we understand that you and some of your associates are proposing to ask the State Legislature at its present session to make some changes or amendments in the North Carolina Drainage District law.

If there is time between now and the date you present this matter, I should be glad to have a copy of your proposed amendments, and inclose herewith a memorandum of some of the points which I think most important.

During the past twenty years we have handled sixty-four different issues of drainage bonds, mostly in the Middle West and Southern States. Some of the suggested changes are from the viewpoint of the banker—that is, changes that will tend to make the securities safe and salable. Others are from the viewpoint of the landowner and are intended to create conditions under which landowners under any proposed project that is feasible from a physical or engineering standpoint can safely include their land in the district and depend upon the increased earnings from the soil to meet the obligations when and as due.

You will realize, of course, that anything that tends to make the securities safe and salable will enable the landowners to obtain capital to make the proposed improvements at less cost, and anything that tends to make the operation safe and profitable for the landowner is a benefit to the bank or bond house handling the securities. In other words, their interests are mutual.

The ideal way to obtain money for such improvements is to have the county lend its credit to the proposed district, spread a special assessment on the property to be improved, which will be held by the county, and let the county issue its direct obligations to raise the money to make the improvement. This is done in the State of Minnesota, which has, I believe, the best drainage law of any State in the Union. We also have a precedent in the State of Virginia, where magisterial districts make a special assessment on all property within that district to cover the cost of road improvement. This obligation is held by the county and county bonds are issued and sold to the public to raise the money to do the work. My observation leads me to believe that the State

Legislature of North Carolina would consider this change too radical, and it may be unwise to even suggest that change at this time.

Our interest in the matter arises from the fact that we now own 30,000 acres of land on the Beaufort Peninsula in Carteret County, which we are now draining. When we bought this land we proposed to finance the drainage operation through a municipal district bond issue, but we and our attorneys later found the law to be unsatisfactory, and that operation has been financed by short-time corporation or mortgage bond issue. We now have an option on another and larger tract in the State, which we will buy and develop with a municipal district bond issue if satisfactory amendments to the present law can be had—not otherwise.

On my last trip to North Carolina I tried to arrange to come via Raleigh to talk these matters over with you, but was called home and could not do so, and am therefore sending you this written memorandum, which I realize may be unsatisfactory in that some of the points, or the reasons for suggesting them, may not be clear to you.

These suggested changes are the result of our own experience and observation and also conferences with bond attorneys and other bond houses of experience and who specialize in this line. We consider these changes important, and trust that you and your associates will give them due consideration.

If any of the suggestions are not clear, I should be glad to explain in detail, or make a trip to Raleigh for a conference with you and others interested.

With best wishes, I am,

Yours very truly,

(Signed) G. S. SPEER,
President.

SPENCER & SPENCER

ATTORNEYS AND COUNSELLORS AT LAW

SWANQUARTER, N. C.

January 30, 1917.

DR. JOSEPH HYDE PRATT,

Chapel Hill, N. C.

DEAR SIR:—We have read the proposed amendments to the drainage law, and find that no amendment is proposed to section 30, chapter 442, Public Laws 1909. As this section now reads, we interpret it to mean that after lateral ditches are constructed by the owner of each tract of land, thereafter such lateral ditches shall be kept in repair by the Board of Drainage Commissioners.

To illustrate, suppose A owns a tract of land that is located one-half mile from a drainage canal which has been constructed by the district, and that there are two or three tracts between this tract and a canal. In the event A cannot acquire a right to drain his tract of land through the lands of parties lying between his land and a canal, this section gives him a right to condemn a right of way for his ditch. Now, after this ditch is constructed, section 30 places the same under the control of the Board of Commissioners of the district and compels them to keep same in repair.

You will readily realize that there will be a network of such ditches ranging in size from 1 to 6 feet wide and from 1 to 3 or 4 feet deep. It will be almost impossible for any district to maintain such ditches, and we do not believe

that the spirit of the law contemplates such. However, it would seem from the wording of this section that this duty is put upon the commissioners. We think that this law ought to be amended in such a manner that the owners of land constructing such ditches shall be required to keep the same in repair.

We merely wish to call this to your attention so that the Legislative Committee of the Drainage Association may incorporate it in the amendments if they see fit to do so.

Yours very truly,

(Signed) SPENCER & SPENCER.

SIDNEY SPITZER & Co.

INVESTMENT

MUNICIPAL AND
GOVERNMENT

BONDS

RAILROAD AND
CORPORATION

JOSEPH HYDE PRATT, *State Geologist,*
Raleigh, N. C.

TOLEDO, O., February 1, 1917.

DEAR SIR:—We are in receipt of your telegram of today reading:

“Would you advise longer maturity for North Carolina Drainage Bonds. Are you satisfied with the law as it now stands. Wire quick.”

In reply to which we have wired you as follows:

“We don't advise longer maturities North Carolina Drainage Bonds. We are satisfied with present law and are creating a market for such bonds.”

By way of further explanation, will state that we do not believe that the maturity of the bonds should be changed, because thirteen years is long enough for any drainage bond to run.

We do not know of any suggestions to make as to your laws, as we feel they are good ones, and we have created quite a market for North Carolina Drainage Bonds issued under these laws, and as far as we are concerned we are perfectly satisfied to handle the bonds under the present law.

If we can be of any further service to you, please command us.

Very truly yours,

(Signed) SIDNEY SPITZER & Co.,
By JOHN S. HARRIS.

SUGGESTED CHANGES IN NORTH CAROLINA DRAINAGE DISTRICT LAW

1. Change in the nomenclature. Drainage district bonds should be known by the county in which the property is located. For example: Adams County Municipal Drainage District, No. 1, No. 2, or No. 3, would find a wider market and more ready sale than Alligator Creek or Dismal Swamp Drainage Districts located in Adams County.

2. Extend the time of payment. Drained land gets better each year after it is drained, tamed, and cultivated. There is no reason, therefore, why

municipal drainage district bonds should not run for twenty-five or thirty years, or even longer. The present program of having 10 per cent of the principal mature the third year and 10 per cent each year thereafter is suicidal and is sure to lead to default and bring North Carolina Drainage District bonds into disrepute. Provision should be made for bonds to mature any time within thirty years and stipulate that not more than 10 per cent of the principal could mature in any one year. The district officials and the bond house bidding on the bonds could then agree upon the maturities, date and place of payment of interest and principal within these prescribed limitations. A reasonable amount of flexibility is most desirable.

3. It should be made the duty of the court under which drainage districts are organized to review the proceedings and certify on the back of each bond, when and as issued, that the court has reviewed the proceedings; that the bonds are regularly and legally issued in accordance with the laws of the State of North Carolina, and this certification should by statute make all bonds so certified forever incontestable.

4. Provision should be made for refunding now or at any future time, because bonds of districts organized under the present law are maturing too fast, and unless relief is given in this or some other manner there is sure to be default.

5. Ample provision should be made for the issuance of drainage district bonds to pay for expenditures previously made and work already done, and this provision should be sufficiently broad to enable an individual or corporation to carry on the work as far as possible with their own resources, even to the completion of all construction work, and then issue district bonds to cover the cost thereof. Bonds issued after the construction work is completed can be sold at a much higher price than will be possible to obtain before the work commenced.

6. The interest rate should be 6 per cent payable semiannually, the time and place of payment to be determined by mutual agreement between the district officials and the bank or bond house contracting for the purchase of the securities, and care should be taken to have one installment of the semiannual interest and payments on principal fall due thirty or sixty days after the date when all taxes are supposed to have been paid.

7. All bond issues should be advertised for public sale in local papers and the financial papers in the leading banking centers, and no bid should be accepted below par and accrued interest. If the bonds cannot be sold at par and interest publicly, provision should be made for their sale privately at a price not below 90 or 95 and interest.

8. All assessments for payment of interest and principal on the bonds and the annual maintenance charges should be spread upon the basis of estimated benefits, for two principal reasons: first, because it is equitable, and, second, because it will furnish a financial statement that can be used to advantage by the bank or bond house purchasing the securities, and will, therefore, result in the district obtaining a better price for its bonds.

Ninety per cent of the individual investors who purchase drainage district bonds are accustomed to buying municipal securities, and therefore accustomed to the present law the assessed valuation is generally less than the bonded debt. A financial statement of the district would therefore be detrimental.

The district directors or commissioners and the engineer in charge, acting under the direction of the court, should estimate the present value of all land within the proposed district and estimate the value of the land when drained. The difference between the present value and the value when drained would be the amount of the benefit to the property owner, and the estimated cost of the work should be assessed on all property within the district on that basis. A rough illustration of a district containing 25,000 acres will make this point more clearly understood:

Acres	Present Value Per Acre	Estimated Value Drained	Per Acre Benefit	Total Benefit	Per Acre Debt
3,000	\$ 2.00	\$ 70.00	\$ 68.00	\$ 204,000.00	\$ 6.80
5,000	5.00	70.00	65.00	325,000.00	6.50
8,000	7.00	70.00	63.00	504,000.00	6.30
5,000	10.00	70.00	60.00	300,000.00	6.00
4,000	25.00	70.00	45.00	180,000.00	4.50

Estimated cost, \$150,000, or approximately \$6 per acre.

The bond house would have a financial statement of the assessed benefits and the total bonded debt would be approximately 10 per cent of that amount. Again:

Acres	Present Value Per Acre	Estimated Value Drained	Per Acre Benefit	Total Benefit	Per Acre Debt
12,000	\$ 2.00	\$ 75.00	\$ 73.00	\$ 876,000.00	\$ 7.30
5,000	5.00	75.00	70.00	350,000.00	7.00
3,000	10.00	75.00	65.00	195,000.00	6.50
1,500	20.00	75.00	55.00	82,500.00	5.50
1,000	30.00	75.00	45.00	45,000.00	4.50
1,000	40.00	75.00	35.00	35,000.00	3.50
1,000	50.00	75.00	25.00	25,000.00	2.50
500	60.00	75.00	15.00	7,500.00	1.50

Estimated cost, \$160,000.

Average cost per acre, approximately \$6.40.

Maximum assessment, \$7.30 per acre.

Minimum assessment, \$1.50 per acre.

Assessed valuation, according to benefits, more than ten times the amount of the debt.

9. *General Taxes.*—The act should stipulate that there should be no increase in the assessed valuation for general taxes on lands within a drainage district while the drainage bonds remain outstanding, or at least for a period of ten years. This arrangement will work no hardship on the other property owners within the county and will be a great benefit to the district landowners, tend to make the drainage bond a better security, and stimulate development by drainage within the State.

10. The annual tax levied for payment of interest and principal on the bonds and the cost of maintenance should be at least 10 per cent in excess of actual requirements, so as to provide against delinquencies, and this 10 per cent excess assessment should continue throughout the life of the bonds, or until such time as this fund, which will accumulate from year to year, reaches an aggregate in cash of not less than 10 per cent of the face value of all outstanding bonds. Any provision made that will insure prompt payment of interest and principal when due will make North Carolina drainage bonds popular and enable property owners to obtain money to make such improvements at a lower cost than would otherwise be possible.

11. Coupons or bonds that are not paid promptly at maturity should bear interest at the highest legal rate during the period of their delinquency.

12. To insure the levying of assessments and the collection of taxes, the law should impose a penalty on district and county officials who fail to perform their duty in this connection.

13. The assessment necessary to pay principal and interest on the bond issue throughout its life should be spread upon the property within the district at the time the bonds are authorized and issued, and this tax lien should follow the land and not the owner.

14. Shorten the time required for the organization of a district, especially where there is no diversity of ownership, or where all property owners sign the original petition.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Out of print.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, 50 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs., 1 map. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Postage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Out of print.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 64 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. 8°, 90 pp. *Postage 10 cents.*

46. The Vegetation of Shackleford Bank, by I. W. Lewis, 1917. 8°, 40 pp., 11 plates. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention. Held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Greensboro, N. C., November 22 and 23, 1916. 110 pp., 8 figs. *Postage 10 cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Out of print.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties. Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley. *In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties. Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes. State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount

Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 20 cents.*

Administrative Report.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 48

FOREST FIRES IN NORTH CAROLINA DURING 1915, 1916 and 1917

AND

PRESENT STATUS OF FOREST FIRE PREVENTION
IN NORTH CAROLINA

BY

J. S. HOLMES, State Forester



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JOSEPH HYDE PRATT, *State Geologist*

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 22, 1918.

To his Excellency, HONORABLE THOMAS W. BICKETT,

Governor of North Carolina.

SIR:—The protection of our forests from fire is generally recognized and urged as a necessary war measure, as well as an essential step towards safeguarding our Nation's future welfare. Owing to the lack of a State appropriation for carrying out the provisions of the forestry law of 1915, education and publicity are practically the only weapons left to the Survey with which to fight this common menace.

A report on the destruction to property in this State by forest fires during the past three years, as reported by correspondents in the various townships, together with a sketch of what has been done to combat this evil, should go far in convincing the people of North Carolina that stronger and more effective measures are a vital necessity.

I, therefore, submit herewith, for publication as Economic Paper No. 48 of the Reports of the North Carolina Geological and Economic Survey, a report on the *Forest Fires in North Carolina During 1915, 1916, and 1917*, and the *Present Status of Forest Fire Prevention in North Carolina*. An Appendix containing a List of Voluntary Township Forest Fire Correspondents who reported for the year 1917 has been added for the information of the general public and as a slight recognition of the free public service rendered by these men and women.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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FOREST FIRES IN NORTH CAROLINA

DURING 1915, 1916, AND 1917

INTRODUCTION

The publishing at this time of a somewhat full report on forest fires might be thought of by those who have given little attention to the subject as a matter not directly affecting the output of timber as a war measure. On the contrary, this subject has a vital relation to the war as well as to the peace which must follow it. Although the future value of the young growth annually killed by fires is greatly in excess of the value of the mature timber destroyed, yet the loss from both these sources as well as by other property injured greatly lessens our efficiency in pushing the war and our prospect of prosperity and progress during the ensuing peace.

Information on the number, extent, and damage annually caused by forest fires in North Carolina has been collected through the coöperation of voluntary correspondents in the various townships of the State for the past nine years. At first, comparatively few townships were heard from, but each succeeding year the results of the inquiry have become more accurate and more complete. This is due to the increasing number of correspondents who report fires and to the better and more general understanding and appreciation of the damage done by them. While in 1909 only 158 replies were received to the list of questions sent out, inquiry for the past two years has elicited slightly over one thousand replies. Even now, however, reports are received from only 65 per cent of the townships of the State.

Reports on forest fires during 1909, 1910, 1911, 1912, 1913, and 1914 were published by the Survey as Economic Papers Nos. 19, 22, 25, 33, 37, and 40, respectively. These reports, several of which are now out of print, have been distributed widely through the State and to select lists of exchanges throughout the whole country. The interest in this question in North Carolina, however, is still much too restricted, although the influence of these inquiries and reports is clearly seen in the greatly improved attitude towards forest fires on the part of landowners and the general public.

It was originally intended that the reports on forest fires for the years 1915 and 1916 should be published separately, as previous reports had been. However, the publication of these reports has been unavoidably delayed until now the figures for the three years 1915, 1916, and 1917 are brought together in one report. Much of the data for the different years has been given to the press from time to time, but its value to the people of the State amply justifies its compilation and publication in this complete report.

FOREST FIRE REGIONS

Experience has shown that the belt of counties running along the eastern slope of the Blue Ridge, and including the many spurs of that range, have fire conditions much more like those in the Mountain region than in the rest of the Piedmont region. In 1915, therefore, reports from this belt of counties, containing Surry, Wilkes, Caldwell, Burke, McDowell, Rutherford, and Polk counties, were added to the Mountain region. This made the Mountain and Piedmont regions more nearly of a size and showed much more accurately the difference in fire risks and fire occurrences in the two regions. This change, however, has neces-

sarily shown a larger fire damage in the Mountain and a less fire damage in the Piedmont regions than formerly. It has, therefore, somewhat impaired the value of average figures for the whole period during which fire statistics have been collected. For this reason the inclusion of the data for the last three years in one report is most appropriate. Most of the average figures contained in the report, therefore, cover only these three years. An exception to this has been made in the comparative statement of averages. Tables 5, 9, and 13.

At the present time the Mountain region comprises all of the counties west of the Blue Ridge, together with the seven counties enumerated above, including the eastern slope of the Blue Ridge. This includes practically all the rough mountain region of the State. The Piedmont region extends from these counties east through the hilly and rolling sections of the State to the "fall" line where the Coastal Plain region commences. Roughly speaking, this division line is marked by the main line of the Seaboard Air Line Railway. The Coastal Plain region extends from here to the coast and includes everything between the sandhills in the southwest part of the region and the Banks on the east. This area is almost level and some of it quite swampy; most of the swamps, however, dry up in the summer or fall and are then almost as susceptible to fire as are the drier areas. Roughly speaking, 75 per cent of the Mountain region, 50 per cent of the Piedmont region, and 65 per cent of the Coastal Plain region is forested.

FIRE SEASONS

In considering the subject of forest fires and their prevention it is important to know at what time of the year the most destructive and dangerous fires may be expected. In order to determine this, correspondents have each year been asked to state what are the worst months for fires in their townships. Replies to this question have formed the basis of tables on seasonal fire risks published in previous reports.

The following table, however, is based chiefly on reports of the actual occurrence of individual fires, and so should be more accurate than earlier similar tables. It is significant, however, as confirming previous conclusions, that this table differs in no essential detail from those earlier tables based on local public opinion.

TABLE 1.—RELATIVE MONTHLY AND SEASONAL FIRE RISKS FOR THREE YEARS, 1915, 1916, AND 1917, IN PERCENTAGES

	MOUNTAIN		PIEDMONT		COASTAL PLAIN		STATE	
	Months	Seasons	Months	Seasons	Months	Seasons	Months	Seasons
March.....	17	63	27	73	23	64	30	74 Spring.
April.....	29		32		28		28	
May.....	17		14		13		16	
June.....	2	5	2	5	7	14	5	10 Summer.
July.....	1		1		3		2	
August.....	2		2		4		3	
September.....	2	25	3	14	3	14	3	18 Fall.
October.....	10		4		5		6	
November.....	13		7		6		9	
December.....	3	7	2	8	4	8	3	8 Winter.
January.....	1		3		1		2	
February.....	3		3		3		3	

FOREST FIRES DURING THE YEAR 1915

The spring fire season of 1915 was about average. March was cold and rather dry, and but few fires occurred in this month. Early in April a change in weather occurred, and from the 6th to the end of the month warm and dry weather prevailed. It was during this period that the worst fires occurred. The counties on the east slope of the Blue Ridge suffered most, though all the mountain counties were seriously affected, while practically all those in the Coastal Plain region reported forest fires. May, according to the weather report, was the wettest May for ten years.

The fall fire season was late in commencing, practically no fires being reported before October 1st. From that time until December 10th fires occurred throughout the State, but in less number and with less severity than usual.

From reports submitted, it appears that 58 per cent of the fires occurred during the spring season, more than one-fourth of the total fires being reported for the month of April. During the fall months about 21 per cent of the total number of fires for the year occurred, 10 per cent being reported for November and 8 per cent for October.

TABLE 2.—FOREST FIRES IN NORTH CAROLINA DURING 1915

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Alleghany.....	7	6	10	11			\$.....		\$.....	\$.....	\$.....	\$.....	\$.....
Ashe.....	15	6	10	11	540	110	293	220	600	450	2,125	140	3,468
Avery.....	8	6	8	12									
Buncombe.....	18	7	10	30	2,317	201	1,293	1,905	755	10	5	1,200	2,062
Burke.....	13	8	10	12	37,000	1,800	5,100	9,500	18,600	16,000	5,000	925	44,700
Caldwell.....	12	6	9	29	24,351	1,200	5,600	21,550	3,500	2,012	15	1,260	11,127
Cherokee.....	6	4	5	27	8,000	150	600	2,000	3,500	1,200	400	175	5,700
Clay.....	5	5	7	38	19,000	860	3,800	12,800	3,440	6,200	900	275	14,340
Graham.....	3	3	9	32	11,800	456	1,615	3,260	1,225	1,200	265	775	4,305
Haywood.....	13	9	13	27	3,930	595	1,700	2,600	7,100	1,000	675	2,670	10,475
Henderson.....	8	7	9	13	2,270	65	960	660	1,360	120	175	105	2,615
Jackson.....	15	8	11	21	12,700	72	228	500	50	383	240	327	901
McDowell.....	11	6	10	34	800	34	72	407	400	230	1,300	175	702
Macon.....	11	7	10	26	2,655	33	89	1,664	754	3		340	2,126
Madison.....	16	11	12	10	16,600	1,057	6,194	3,700	3,050	2,250	1,500	325	12,994
Mitchell.....	10	6	10	31	200	10	20	100	250	25	1,490	100	1,795
Polk.....	6	6	11	18	5,960	190	335	7,100	5,700	1,800	2,085	325	9,910
Rutherford.....	14	9	13	33	3,204	796	1,915	2,140	3,915	1,405	1,205	840	8,440
Surry.....	14	14	27	10	1,050	215	690	285	135	620	120	225	1,565
Swain.....	4	2	3	20	10,725	90	250	20,500	5,200	1,000	1,000	150	7,450
Transylvania.....	8	6	10	44	3,000	200	800	700	640	500	300	200	2,240
Watauga.....	13	9	14	7	1,200	275	1,900	30	100	350		95	2,350
Wilkes.....	21	17	35	35	8,504	2,305	4,275	7,750	6,125	6,995	6,700	1,290	24,095
Yancey.....	11	11	15	17	331	81	335	200	175	200	700	185	1,410
Totals.....	262	179	281	495	176,137	10,795	38,064	99,571	66,574	43,953	26,200	12,102	174,791

TABLE 3.—FOREST FIRES IN NORTH CAROLINA DURING 1915

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Re- ceived	Number of Fires	Total Number Acres Burned Over	Merchantable Timber De- stroyed, M.	Value of Tim- ber Destroyed	Acres Young Growth De- stroyed	Value Young Growth De- stroyed	Value Products Destroyed	Value Improve- ments De- stroyed	Cost of Fighting Fires	Total Damage Reported
Alamance.....	14	7	9	4	1,730	5	\$ 17	1,430	\$1,700	\$ 80	\$.....	\$ 50	\$ 1,797
Alexander.....	8	6	7	3	121	100	350	66	250	400	200	15	1,200
Anson.....	8												
Cabarrus.....	13	8	10										
Caswell.....	9	6	7										
Catawba.....	8	5	11	3	50	2	8	50	100	107		25	215
Chatham.....	13	5	6	2	10			10	10			5	10
Cleveland.....	11	8	10	3	125	15	30	125	125	50		5	205
Davidson.....	18	6	6	1	15	16	30	3	25	20			75
Davie.....	7	7	13										
Durham.....	7	2	2										
Forsyth.....	14	10	12	1									
Franklin.....	10	3	6	35	6,000	200	1,000	650	4,000	500	800	250	6,300
Gaston.....	6	4	8	9	1,019	33	152	240	1,765	362		175	2,279
Granville.....	9	7	9	7	1,050	10	30	520	25	555	1,500	5	2,115
Guilford.....	18	10	12	5	534	100	250	216	297	400	150		1,097
Iredell.....	16	6	10	7	69	10	50	30	155	270	50	28	525
Lee.....	7	3	3										
Lincoln.....	5	1	1										
Mecklenburg.....	15	10	15	3	15								
Montgomery.....	11	9	9	13	2,854	61	279	300	500	190		40	969
Moore.....	9	8	16	21	13,000	1	5	13,000	11,000	2,010	300	200	13,315
Orange.....	7	4	5	1	10			10	10				10
Person.....	9	3	4				350	300	300	750		25	1,400
Randolph.....	20	7	10	9	1,425	135							
Rockingham.....	11	4	6										
Rowan.....	14	8	11	17	282	25	150	102	510	160	1,400	50	2,220
Stanly.....	10	1	1	2	175	12	60	25	50	40			150
Stokes.....	9	2	3	1	150			150	12	12			24
Union.....	9	7	9										
Vance.....	9	5	6	1	75			75	75				75
Wake.....	19	3	3	13	1,200	200	500	1,100	1,100			225	1,600
Warren.....	12	8	11	36	1,620	600	240	945	6,000	1,400	250	70	7,890
Yadkin.....	9	7	14	3	60	1	5	45	70	110	1,250	10	1,435
Totals.....	374	190	265	200	31,500	1,500	3,500	19,400	28,100	7,400	5,900	1,180	44,900

TABLE 4.—FOREST FIRES IN NORTH CAROLINA DURING 1915

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Beaufort.....	6	1	1				\$		\$	\$	\$	\$	\$
Bertie.....	9	8	16	19	4,560	735	2,210	3,610	8,175	755	330	125	11,470
Bladen.....	15	4	4	1	25	10	50	25	20	125		5	195
Brunswick.....	6	1	1	7	11,000	150	525	7,000	24,000	7,000	2,500	35	34,025
Camden.....	3	1	1										
Carteret.....	10	3	3	5	5,000	25	100	5,000	1,000	50	10		1,160
Chowan.....	4	4	4	2	20			20	20				20
Columbus.....	14	9	18	81	20,960	2,000	3,500	12,800	8,700	6,050	1,000	825	19,250
Craven.....	9	4	7	13	10,000	320	1,180	6,000	10,000	2,200	1,500	300	14,880
Cumberland.....	11	5	7	62	3,500	1,050	1,130	2,000	1,500	350	6,200	200	9,180
Currituck.....	5	4	4										
Dare.....	5	1	1	8	300	5	10	150	250		1,600		1,860
Duplin.....	13	4	4	4	120	30	35	10	100	230	500	75	865
Edgecombe.....	14	7	9	5	950	510	1,565	830	2,430	55	10		4,060
Gates.....	7	4	4	13	590			590	1,095				1,095
Green.....	9	4	6	7	1,200	110	450	850	1,000	1,000			2,450
Halifax.....	12	3	4	9	450	15	60	375	325		15,000	10	15,285
Harnett.....	13	12	12	8	40,910	150		1,435	1,435	1,000	200	1	2,635
Hertford.....	6	3	3	3	250	100		250	250				250
Hoke.....	8	3	3	11	2,000	55	15			100	200		315
Hyde.....	5	3	5	2	50	202		50	50				50
Johnston.....	17	6	9	3	250	150	225	150	300			100	525
Jones.....	7	1	1										
Lenoir.....	12	7	7	6	850	100	400	350	250	50	275	50	975
Martin.....	10	2	2	5	500	55	200	375	500	180	25	75	905
Nash.....	15	10	10	34	3,110	202	707	2,212	3,650	3,220	1,000	270	8,577
New Hanover.....	5	1	1	2	200	4	20	100	100		50	10	170
Northampton.....	9	7	14	12	4,220	120	360	4,155	18,175	50	850	110	19,435
Onslow.....	5	2	3	9	22,000	1,900	9,400	22,000	9,000	2,800	1,900	200	23,100
Pamlico.....	5	2	4										
Pasquotank.....	6	2	4	5	245	10	40	200	1,000	15	1,000	100	2,055
Pender.....	10	6	8	47	54,400	2,200	6,650	27,050	54,350	2,800	1,150	650	64,950
Perquimans.....	5	3	3	4	500			200	750				750
Pitt.....	12	8	10	16	4,900	276	699	4,150	17,260	2,150	5,500	300	25,609
Richmond.....	7	5	5	4	1,000	10	10	700	500	400	100		1,010
Robeson.....	25	11	18	36	9,100	322	739	4,205	4,310	830	765	388	6,644
Sampson.....	16	12	12	5	720	290	800	500				100	800
Scotland.....	4	1	1										
Tyrrell.....	5	1	1	3	400	100	500					100	500
Washington.....	4	2	3										
Wayne.....	12	4	5	1	2			2	5				5
Wilson.....	10	6	6	4	250	30	150	50	100	25	50	25	325
Totals.....	385	187	244	456	204,532	11,246	31,730	107,394	170,600	31,435	41,715	4,054	275,480

TABLE 5.—FOREST FIRES IN NORTH CAROLINA DURING 1915
COMPARATIVE STATEMENT OF AVERAGES BY REGIONS FOR 1915 AND FOR SEVEN YEARS

	MOUNTAIN		PIEDMONT		COASTAL PLAIN		STATE	
	1915	Average for 7 Years	1915	Average for 7 Years	1915	Average for 7 Years	1915	Average for 7 Years
Percentage of townships reporting.....	70	45	51	44	51	36	56	42
Average area of each fire, in acres....	334	817	107	398	449	626	303	578
Average damage by each fire.....	\$ 378.00	\$1,264.00	\$ 230.00	\$ 658.00	\$ 613.00	\$1,015.00	\$ 445.00	\$ 934.00
Average area burned over per township reporting, in acres.....	984	*1,538	166	*625	1,094	*1,259	759	*947
Average damage per acre burnt....	\$ 1.06	\$ 1.44	\$ 1.46	\$ 1.62	\$ 1.37	\$ 1.73	\$ 1.30	\$ 1.56
Average damage per township reporting.....	\$1,044.00	\$2,979.00	\$ 243.00	\$ 773.00	\$ 611.00	\$1,429.00	\$ 922.00	\$1,552.00

*Average for six years; no township figures for 1909.

From the foregoing tables it is seen that during 1915 both the area burned over and the total damage reported was only about one-third of the average for the past seven years; although the number of fires was up to the average. It is noticeable that the average damage per acre is less than usual. This is, undoubtedly, due to the fact that in light fire seasons, only areas which have been in the habit of being burned are likely to catch fire; while those that have been protected are fairly free from fire. During a light fire season, the land is easily protected, if ordinary care and foresight are used; whereas, during a serious season, fires are liable to break out anywhere, even with more than the usual watchfulness.

FOREST FIRES DURING THE YEAR 1916

The spring forest fire season of 1916 was the worst so far recorded during the eight years that fire statistics have been collected. It has been estimated that approximately three million dollars was lost through forest fires in North Carolina in the spring season alone.

The dry weather commenced late in February and, with only occasional very light rains, continued until the end of May, the heavy general rains from May 22-24 and again from May 28-30 ending the dangerous season. Exceptionally high winds and hot drying weather prevailed at the end of March and throughout April; and it was during this time that the worst fires occurred.

The fall fire season was the mildest so far experienced. The first killing frost came two weeks later than usual, and the summer weather continued up almost to the end of October. Heavy general rains, October 18-20, made the woods safe until the end of the month. There was less wind than usual, and few serious fires occurred.

Approximately 77 per cent of the fires occurred during the spring; March being credited with 25 per cent, April 33 per cent, and May 19 per cent. No other month in the year claimed more than 5 per cent of the fires.

TABLE 6.—FOREST FIRES IN NORTH CAROLINA DURING 1916
SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Re- ceived	Number of Fires	Total Number Acres Burned Over	Merchantable Timber De- stroyed, M.	Value of Tim- ber Destroyed	Acres Young Growth De- stroyed	Value Young Growth De- stroyed	Value Products Destroyed	Value Improve- ments De- stroyed	Cost of Fighting Fires	Total Damage Reported
Alleghany.....	7	6	9	1	10	5	\$.....	5	\$1,000	\$.....	\$ 200	\$.....	\$ 1,200
Ashe.....	15	5	11	11	368	70	330	252	1,750	1,200	2,185	45	5,465
Avery.....	8	4	8	13	4,540	2,220	10,700	3,050	50,250	100	1,000	610	62,050
Buncombe.....	18	10	14	29	1,075	770	2,415	615	1,515	1,090	250	910	5,270
Burke.....	13	11	20	51	26,105	5,960	26,260	8,305	15,900	19,400	2,250	2,170	63,810
Caldwell.....	12	12	29	50	16,100	6,235	25,690	4,750	6,935	18,750	3,125	1,110	54,500
Cherokee.....	6	4	5	43	15,500	775	2,350	250	300	400	875	225	3,925
Clay.....	5	4	11	25	9,000	760	3,540	1,920	3,100	5,000	125	110	11,765
Graham.....	3	3	4	5	4,000	200	800	3,000	6,000	1,000	1,000	100	8,800
Haywood.....	13	9	16	45	16,975	10,031	50,129	95	3,100	1,200	3,250	385	57,679
Henderson.....	8	8	20	34	3,720	865	3,525	2,875	8,150	30,400	-----	525	42,075
Jackson.....	15	8	13	53	4,132	337	1,400	2,800	2,785	1,125	300	1,138	5,610
Macon.....	11	11	17	18	11,197	5	45	5,134	680	20,100	590	95	21,415
Madison.....	16	12	17	34	10,300	147	734	1,070	1,410	1,800	850	170	4,794
McDowell.....	11	8	14	24	23,625	1,575	6,325	2,450	51,820	1,095	6,650	805	65,890
Mitchell.....	10	6	10	5	40	3	12	20	250	-----	1,000	-----	1,262
Polk.....	6	5	14	43	3,910	1,148	3,592	2,175	9,525	12,400	725	125	26,242
Rutherford.....	14	11	16	52	5,324	566	3,894	1,849	5,160	5,963	2,275	735	17,292
Surry.....	14	12	27	32	3,570	552	588	1,320	2,010	9,050	1,750	275	13,398
Swain.....	4	2	3	6	7,050	620	1,300	2,000	3,500	15,100	2,000	1,050	21,900
Transylvania.....	8	6	10	45	3,650	600	1,200	1,625	6,500	6,000	-----	540	13,700
Watauga.....	13	10	20	17	1,627	115	545	560	1,040	10,100	425	205	12,110
Wilkes.....	21	20	47	82	14,615	7,756	29,565	6,047	22,320	15,070	9,000	2,450	75,955
Yancey.....	11	10	17	17	2,916	155	610	1,831	9,150	5,700	1,300	2,175	16,760
Totals.....	262	197	372	735	189,349	41,450	175,549	53,998	214,150	182,043	41,125	15,953	612,867

TABLE 7.—FOREST FIRES IN NORTH CAROLINA DURING 1916

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Alamance.....	14	6	11	11	110	31	\$ 155	54	\$ 220	\$3,320	\$-----	\$-----	\$ 3,695
Alexander.....	8	7	9	4	5,535	100	18,120	5	100	-----	1,430	-----	19,650
Anson.....	8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cabarrus.....	13	8	10	13	61	62	360	7	585	840	515	100	2,300
Caswell.....	9	5	6	2	25	-----	-----	-----	-----	-----	-----	25	-----
Catawba.....	8	5	8	8	70	242	420	58	440	181	-----	310	1,041
Chatham.....	13	6	4	6	2,125	2	5,010	100	500	20	5	200	5,535
Cleveland.....	11	9	21	45	2,084	188	1,240	780	9,495	12,075	310	515	23,120
Davidson.....	18	10	17	39	288	190	815	60	590	1,150	770	195	3,325
Davie.....	7	7	9	5	50	-----	100	20	215	-----	-----	25	315
Durham.....	7	4	6	9	545	-----	40	13	4,196	-----	5,100	-----	9,336
Forsyth.....	14	7	7	2	35	-----	300	5	25	-----	500	-----	825
Franklin.....	10	6	7	20	11,100	20	2,580	10,104	5,550	5,000	1,000	400	14,130
Gaston.....	6	4	7	16	1,282	24	2,802	1,233	3,000	895	1,700	133	8,397
Granville.....	9	8	14	16	308	60	450	183	1,500	2,000	100	60	4,050
Guilford.....	18	8	10	5	200	2	20	52	150	300	40	25	510
Iredell.....	16	9	10	21	496	105	220	110	5,500	4,000	3,350	75	13,070
Lee.....	7	5	13	11	6,300	85	325	6,250	18,750	9,250	1,650	150	29,975
Lincoln.....	5	5	11	6	95	80	320	35	-----	-----	-----	-----	320
Mecklenburg.....	15	10	12	3	8	10	-----	3	-----	-----	-----	-----	-----
Montgomery.....	11	10	16	45	17,603	2,215	7,880	10,787	31,135	28,310	1,050	690	68,375
Moore.....	9	7	8	18	14,800	1,150	5,600	800	6,500	5,600	900	700	18,600
Orange.....	7	2	3	1	200	-----	-----	200	2,000	-----	-----	-----	2,000
Person.....	9	3	4	1	5	-----	-----	-----	-----	-----	-----	-----	-----
Randolph.....	20	9	12	12	410	110	430	375	1,300	1,000	300	150	3,030
Rockingham.....	11	5	6	9	211	30	105	31	410	100	-----	60	615
Rowan.....	14	8	12	8	204	5	1,050	97	165	250	100	30	1,565
Stanly.....	10	6	6	17	153	5	25	87	650	-----	25	60	700
Stokes.....	9	4	4	6	1,400	-----	300	1,225	5,000	4,000	-----	500	9,300
Union.....	9	8	9	9	263	10	85	120	575	800	-----	85	1,460
Vance.....	9	4	6	3	25	-----	500	15	100	-----	-----	-----	600
Wake.....	19	7	6	17	4,010	-----	20,000	160	700	20,000	-----	75	40,700
Warren.....	12	6	12	68	2,100	217	2,170	1,100	6,700	9,585	1,250	205	19,705
Yadkin.....	9	7	15	31	470	205	1,925	144	1,340	875	1,630	150	5,770
Totals.....	374	215	311	487	72,571	5,058	73,347	34,213	107,391	109,551	21,725	4,918	312,014

TABLE 8.—FOREST FIRES IN NORTH CAROLINA DURING 1916

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Re- ceived	Number of Fires	Total Number Acres Burned Over	Merchantable Timber De- stroyed, M.	Value of Tim- ber Destroyed	Acres Young Growth De- stroyed	Value Young Growth De- stroyed	Value Products Destroyed	Value Improve- ments De- stroyed	Cost of Fighting Fires	Total Damage Reported
Beaufort.....	6	5	6	31	47,000	10,100	\$31,300	6,500	\$17,000	\$ 4,000	\$14,000	\$.....	\$ 66,300
Bertie.....	9	8	12	25	22,125	1,195	5,440	20,550	43,500	140,030	55,125	315	244,095
Bladen.....	15	10	16	42	32,500	5,620	17,100	21,900	31,700	58,625	2,500	3,600	109,925
Brunswick.....	6	5	5	15	20,500	3,040	20,080	6,500	17,000	18,902	2,850	1,350	58,832
Camden.....	3	2	2										
Carteret.....	10	5	6	7	51,000	15,250	76,000	250	13,000	50,000	5,300	1,000	144,300
Chowan.....	4	2	2	6	1,540	150	500	525	1,050	350	50	325	1,950
Columbus.....	14	10	16	152	89,614	5,810	15,830	18,880	80,525	20,840	20,425	6,275	137,620
Craven.....	9	6	12	16	82,700	50,100	252,500	15,000	15,000	30,000	1,500	2,000	299,000
Cumberland.....	11	6	7	30	27,020	21,000	53,000	10,600	6,000	46,000	23,200	1,000	128,200
Currituck.....	5	4	7										
Dare.....	5	1	1	4	400			100	500	500			1,000
Duplin.....	13	6	6	37	6,640	1,150	4,800	1,440	3,500	8,000	200	325	16,500
Edgecombe.....	14	11	20	31	7,525	302	2,730	2,935	11,750	2,900	1,125	520	18,505
Gates.....	7	5	6	22	1,500	50	5,250	1,000	5,000	20,000	75,050	1,000	105,300
Greene.....	9	6	9	12	705	25	20	310	1,100	650	2,000	10	3,770
Halifax.....	12	9	10	92	28,150	910	7,740	16,050	31,550	35,500	12,350	400	87,140
Harnett.....	13	10	14	29	22,675	220	1,070	21,455	10,580	102,275	3,750	3,180	117,675
Hertford.....	6	3	3	1	50	40	200	50	150	350		10	700
Hoke.....	8	2	2	7	13,000	525	2,100	1,300	2,000	500	1,200	200	5,800
Hyde.....	5	4	11	10	11,060	1,110	6,050	5,500	52,000	103,400	1,100	650	162,500
Johnston.....	17	9	11	15	1,925	210	4,040	1,025	600	1,000	5,100	250	10,740
Jones.....	7	5	7	17	20,500	2,900	11,800	10,300	12,400	8,500	1,800	700	34,500
Lenoir.....	12	7	10	27	2,350	250	3,100	1,075	2,050	2,950	910	450	9,010
Martin.....	10	2	1	10	13,000	5,000	25,000				13,000		38,000
Nash.....	15	10	10	26	1,935	66	270	675	1,180	1,925	750	860	4,125
New Hanover.....	5	3	4	10	3,000		3,500	1,000	10,150		2,000	100	15,650
Northampton.....	9	7	10	20	11,580	510	2,045	6,403	42,815	40	3,110	185	48,010
Onslow.....	5	1	2	8	20,000	750	3,000	6,000	12,000		3,000	300	18,000
Pamlico.....	5	3	3	11	5,775	1,150	10,600	900	700	200	4,400		15,900
Pasquotank.....	6	4	7	5	1,100	1,025	4,125	35	450	2,500	150	150	7,225
Pender.....	10	8	13	51	78,800	19,500	52,600	14,500	89,500	5,800	35,800	2,350	183,700
Perquimans.....	5	2	3	2	10			10	100				100
Pitt.....	12	10	13	35	3,750	300	15,850	3,100	29,000	512	1,760	2,600	47,122
Richmond.....	7	5	9	26	18,025	2	10	7,115	100	900	1,000	750	2,010
Robeson.....	25	11	17	53	21,525	2,585	10,320	19,415	25,000	120,400	1,400	675	157,120
Sampson.....	16	12	13	26	18,800	8,850	44,100	5,200	9,000	8,400	20,200	2,470	81,700
Scotland.....	4	3	3	3	10,115	100	400						400
Tyrrell.....	5	5	8	6	2,460	150	1,100	200	5,500			50	6,600
Washington.....	4	2	6	53	14,500	300	1,300	12,500	5,000	4,500	1,000	1,300	11,800
Wayne.....	12	7	9	13	275	300	1,140	155	600	1,840	1,125	240	4,705
Wilson.....	10	4	3	4	175	25	2,100	25	200	1,350	600	100	4,250
Totals.....	385	240	335	990	715,304	201,735	698,110	389,983	589,250	803,639	318,830	35,690	2409,829

TABLE 9.—FOREST FIRES IN NORTH CAROLINA DURING 1916
COMPARATIVE STATEMENT OF AVERAGES BY REGIONS FOR 1916 AND FOR EIGHT YEARS

	MOUNTAIN		PIEDMONT		COASTAL PLAIN		STATE	
	1916	Average for 8 Years	1916	Average for 8 Years	1916	Average for 8 Years	1916	Average for 8 Years
Percentage of townships reporting.....	75	49	58	46	62	39	64	45
Average area of each fire, in acres.....	257	747	150	367	712	637	442	561
Average damage by each fire.....	\$ 831.00	\$1,153.00	\$ 598.00	\$ 651.00	\$2,755.00	\$1,233.00	\$1,646.00	\$1,023.00
Average area burned over per township reporting, in acres.....	959	*1,273	340	*584	2,979	*1,505	1,482	*1,023
Average damage per acre burnt ...	\$ 3.24	\$ 1.67	\$ 4.00	\$ 1.92	\$ 3.83	\$ 1.99	\$ 3.60	\$ 1.82
Average damage per township reporting.....	\$3,107.00	\$2,995.00	\$1,353.00	\$ 844.00	\$11,405.00	\$2,676.00	\$5,583.00	\$2,056.00

*Average for seven years; no township figures for 1909.

The forest fire damage for 1916 broke all previous records. The total number of fires and the total area burned over were more than double that of any previous year, not only for the whole State, but in each of the three regions of the State. The total reported damage amounted to over \$3,640,000, or more than three times the damage before reported. Most of this loss occurred during April and May, as the fall fire season was less serious than usual. Numbers of the fires burned for many days, causing hundreds of thousands of dollars worth of damage each. Because of this large destruction, extra expenditures were necessary for fighting fires and we have reported an expenditure of \$56,000 by private individuals fighting fire. This, undoubtedly, is a very small estimate, as it is said that at one fire alone, in McDowell and Burke counties, five hundred men were employed and they were fighting fire for several days.

PRESS ACCOUNTS OF THE SPRING FIRES

Newspaper reports, although in some cases exaggerated, give a good idea of the conditions prevailing in all parts of the State during the latter half of April and early in May, 1916. For their historic as well as descriptive value, a number of quotations are here given.

FOREST FIRE IS RAGING IN McDOWELL COUNTY

HAS SPREAD TWENTY MILES AND DESTROYED NUMEROUS BUILDINGS

MARION, N. C., April 23.—A forest fire, originating at or near Hankins, covering in width several miles, has been raging for twenty-four hours in McDowell County, and already has extended twenty miles toward Burke County. A church, a school building, a large mill, and a dozen farmhouses have been burned. It would be impossible to estimate the timber loss. A call reached Marion last night for help to fight the fire, and many automobiles loaded down with fire fighters were rushed to the country, but the fight was altogether in vain. Nothing but rain or some wide stream of water can stem the raging torrent of fire.—*Asheville Citizen*, April 24, 1916.

MORE FOREST FIRES IN McDOWELL COUNTY—PROPERTY LOSS EXTENSIVE

MARION, April 24.—Three more forest fires broke out in McDowell County Sunday afternoon, one on Armstrong Creek, one on Buck Creek, one on Hickorynut Mountain. The Buck Creek fire is threatening the Appalachian forest reserve. The forest depart-

ment secured every available man to fight the fire. Every known plan of fire fighting has been tried with but little success. Today at noon there is every appearance of rain, the only thing that can conquer the fire.

Hundreds of thousands of dollars in property value has been destroyed. The Hankins fire that has been spreading towards Burke County, in the estimate of a well-known citizen, has already destroyed \$200,000 worth of property.

Marion was surrounded by fire last night.—*Charlotte Observer*, April 25, 1916.

WESTERN FORESTS SWEEPED BY FLAMES

MILLIONS OF FEET OF LUMBER HAVE BEEN DESTROYED IN CALDWELL AND ALEXANDER

LENOIR, April 25.—Forest fires of a most terrific and destructive nature have been raging in the northern section of Caldwell and Alexander counties for the last several days. Lumber and timber, aggregating millions of feet, and a number of sawmills have been destroyed by the angry flames, which were driven at a furious speed by high winds.

The two sections of Caldwell that seem to have suffered the greatest damages from the flames are the Globe and Edgemont communities.

It was found to be impossible to check the flames on the mountain sides, so fierce was the speed at which they raced, a distance of some five miles having been covered in thirty-five minutes, it is asserted on good authority.—*News and Observer*, April 26, 1916.

BAD FOREST FIRE NEAR ASHEVILLE

UNITED STATES FIRE WARDENS, ASSISTED BY 1,000 MOUNTAIN CITIZENS,
FIGHT FLAMES

DAMAGE HALF-MILLION

FIRE WAS APPROACHING BLACK MOUNTAIN AND NATIVES FIGHTING FOR HOMES AND TIMBER

ASHEVILLE, May 9.—Starting in the Murchison boundary in Yancey County Friday afternoon and sweeping thence across the Perley and Crockett boundaries along Mount Mitchell, the worst forest fire in the history of Western North Carolina leaped across the gap at North Fork this afternoon into the Asheville watershed and tonight is raging in that section with 1,000 men from Black Mountain, Marion, Old Fort, Asheville, Montreat, and other points fighting desperately under the direction of United States fire wardens employed on the various protected districts.—*Charlotte Observer*, May 10, 1916.

BLACK MOUNTAIN FIRE NOW UNDER CONTROL

DAMAGE LOSS ESTIMATED AT HALF-MILLION—SHIFT OF WIND THE DANGER

ASHEVILLE, May 10.—Unless there is a change in the direction of the wind the great forest fire, which has done upwards of a half-million dollars damage to the Asheville watershed and adjacent property beyond Black Mountain, has been checked.

The fire was under control this morning, although the flame fighters remained on the grounds until this afternoon. Even yet there are several hundred men watching that no further outbreak occurs.

The fire, which broke into the watershed property between Potato Top Mountain and Toe River Gap, burned fiercely in the spruce, with which most of the watershed is timbered, and made a difficult fire to fight. Back-firing was employed in most instances and by 10 o'clock this morning the flames were under control.

Accurate estimates of the damage are impossible, but officials state that the loss will be at least a half-million dollars, perhaps more. Strict watch is being kept for fear of a shift in wind, which would in all probability start the flames again.—*Charlotte Observer*, May 11, 1916.

SUNBURST WAS THREATENED WITH A FOREST FIRE

ASHEVILLE, May 8.—Sunburst, a lumber town situated in Haywood County, a few miles from Canton, was seriously threatened yesterday by a forest fire, which raged for three days over the cut-over lands of the Champion Lumber Company.—*Charlotte Observer*, May 9, 1916.

FOREST FIRES ARE RAGING IN RONDA SECTION, WILKES

ELKIN, April 21.—Forest fires are raging in Wilkes County, not many miles from this place. The fires are doing the worst damage in the big woods of the Ronda section of Wilkes. Much valuable timber has already been destroyed and so far the fire fighters have not been successful in extinguishing the flames. Signs of rain give hope to those who are in the danger zone.—*Winston-Salem Journal*, April 22, 1916.

FOREST FIRES RAGING IN IREDELL COUNTY

STATESVILLE, May 4.—Two forests in the southeastern section of this county were burned over Wednesday and a third fire was reported as doing great damage in Chambersburg Township yesterday. All the men and boys of the Shiloh Church community organized yesterday and began work some distance ahead of the fire, raking back leaves and clearing an area across one of the big tracts of timber with the hope of checking the flames when they reached that point. The extent of the damage of the fires is inestimable. Time only can tell the damage to the growing timber. Much cordwood which was cut and corded has been burned and some lumber, but so far as known no buildings of consequence have been destroyed in this section.—*Twin City Daily Sentinel*, May 4, 1916.

DESTRUCTIVE FOREST FIRES IN THE GARLAND SECTION

ESTIMATED LOSS BETWEEN \$25,000 AND \$50,000—LARGE AREAS SWEEPED

GARLAND, N. C., May 11.—Loss estimated at between \$25,000 and \$50,000 in timber and turpentine resulted from forest fires which raged in this section of Sampson County Sunday afternoon, sweeping over a section of about ten miles long and five miles wide, destroying a negro church, some stables, and a barn, but no residences, though a number of homes were threatened. It was the most destructive forest fire known in this section in many years.—*Wilmington Star*, May 12, 1916.

CUMBERLAND MAN DEAD AS RESULT OF FOREST FIRES

DISASTROUS CONFLAGRATION RAGING IN THE FAYETTEVILLE SECTION OF STATE.

FAYETTEVILLE, April 15.—One man is dead and thousands of dollars worth of property destroyed by a forest fire which at last accounts was still raging in Beaver Dam and Cedar Creek townships, this county. Daniel B. Carter, a well-known farmer, was overtaken by the fire while he was walking on the public road and was burned to death. The home of Purdie Hall, with all its contents, was burned. The fire swept a wide area ten miles long through Cedar Creek and Beaver Dam townships, on either side of the highway through that section.—*News and Observer*, April 16, 1916.

MUCH DAMAGE DONE BY FOREST FIRES—CHURCH DESTROYED

Considerable damage was done in the western part of the county yesterday by fires starting from brush-piles and spread by the high gale which blew in that section during the day.

Fire broke out in Rodman's Swamp yesterday and destroyed the St. James Episcopal Church, between Pantego and Haslin, one of the oldest Episcopal churches in the county. It also burned to the ground a tenement house on the farm of D. Lesofsky.—*Washington News*, April 15, 1916.

CHURCH WAS BURNED

SOUTHPORT, April 15.—Forest fires raged in several sections of Brunswick Friday, much damage being done to fences and timber. The New Hope Methodist Church, located near Seaside in the southern part of the county, was totally destroyed.—*News and Observer*, April 17, 1916.

FOREST FIRES SWEEP SECTION NEAR WILMINGTON

OLDEST CITIZENS SAY THEY HAVE NEVER BEFORE SEEN ANYTHING LIKE IT
VALUABLE TIMBER HAS BEEN DESTROYED

SAWMILL, CHURCH, FARM BUILDINGS, AND SMALL RESIDENCES REDUCED TO ASHES

Great forest fires are raging in all sections of the country contiguous to Wilmington, according to passengers arriving today from the railroad lines leading out of the city.

In Pender, Columbus, Bladen, Sampson, and Brunswick counties timber valued at untold thousands of dollars has been destroyed, and not a few buildings, including at least one sawmill, a church, many negro houses, and several barns and stables.—*Wilmington Dispatch*, April 24, 1916.

FOREST FIRE NOW RAGES IN ONSLOW

FLAMES DESTROY BUILDING AND TENEMENT HOUSES

NEW BERN, N. C., April 25.—One of the most disastrous forest fires in the history of that section is now raging in Onslow County, and reports from all parts of the county are to the effect that great damage is being done.

Yesterday afternoon at Dixon, near Jacksonville, the flames destroyed the school-house and several tenement houses owned by Mr. W. J. Wilkins. Thousands of dollars worth of damage has been done to the timber growth and the fire is still burning fiercely.

In the lower part of Craven County and in Carteret County the forest fires have gained fresh impetus and are doing great damage.—*Wilmington Dispatch*, April 25, 1916.

FOREST FIRES IN PENDER

FARMERS EAST AND WEST OF BURGAW SUFFER MUCH LOSS—FIRES SWEEP BY WIND

BURGAW, N. C., April 13.—Great damage has been done and more is threatened by forest fires which have been raging all day east and west of Burgaw. Farmers have suffered great loss. A high wind has prevailed all day and, the woods as dry as they are, it has been impossible to stop the fires.—*Wilmington Star*, April 14, 1916.

Speaking of the damage done by these same fires, Mr. B. F. Keith of Currie, Pender County, wrote the State Forester on January 24, 1918, in part as follows:

"I had occasion to travel by private conveyance last summer (1917) from St. Pauls in Robeson County to my home in Pender County, a distance of nearly one hundred miles, and was not out of sight of the destruction caused by the fire an hour at a time from St. Pauls to my home, and could have gone fifty miles on to the ocean with the destructive course of the fire. The same thing would have been seen had I gone north through Cumberland, Sampson, Duplin, and Jones counties, or I would have seen the same destructive sight by going through Columbus and Brunswick to the ocean.

"It is true this vast territory was burned over in 1916; nevertheless, the forest, old and young, was almost completely destroyed, and it will take at least a generation for it to become reforested. Had it been protected as it should have been, by compulsory legislation, the State and its citizens would have been saved millions of dollars yearly."

FOREST FIRES DURING THE YEAR 1917

Both the spring and fall fire seasons of 1917 were considerably below the average, both in length and in seriousness of the fire risks. This was partly due to the large amount of land burned over in 1916, but also largely to the comparatively favorable season. Credit must be given, however, to the increased interest of landowners in forest protection and their desire to prevent a repetition of the losses of 1916. Probably the enormous damage suffered the previous year had an educational value in enforcing the lessons which have been brought out in a number of ways by the Survey, the Forestry Association, the Women's Clubs, and other organizations.

The spring fire season started later than usual; the first Federal patrolman not being appointed until April 2. The chief danger season ended with the month of May, although some of the patrolmen remained on duty until the middle of June. Light rains occurred throughout the danger season; the longest period without any rain being about ten days in the middle of May. Few days of high wind were reported.

The fall fire season did not start until early in November and was over by December 8, lasting only about five weeks. During this time there were, in most places, a number of light rains or snows and little or no wind was experienced.

The township correspondents reported that 58 per cent of the fires occurred during the spring months, distributed as follows: 19 per cent in March, 25 per cent in April and 14 per cent in May. The fall fire season was more serious than usual in the mountains, 12 per cent of the mountain fires occurring in October and 19 per cent in November. Taking the State as a whole, however, only 22 per cent of the fires occurred in the fall, one-half of those being in November.

TABLE 10.—FOREST FIRES IN NORTH CAROLINA DURING 1917
SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Alleghany.....	6	11	5	95	81	\$ 400	30	\$ 50	\$1,200	\$ 150	\$ 235	\$ 1,800
Ashe.....	11	16	17	565	51	395	135	550	500	2,125	30	3,570
Avery.....	5	6	8	350	220	200	200	600	200	1,110	115	2,110
Brunswick.....	9	16	23	1,050	512	2,060	615	2,325	5,700	775	650	10,860
Burke.....	9	15	43	1,277	578	1,375	570	2,700	2,702	2,200	320	8,977
Caldwell.....	12	26	50	2,885	2,296	6,205	1,943	5,250	11,950	3,575	582	26,980
Cherokee.....	4	8	46	2,100	130	415	480	700	250	180	50	1,545
Clay.....	5	10	21	3,400	200	850	325	1,250	25	100	240	2,225
Graham.....	2	2	3	1,200	200	400	1,100	6,000	1,000	50	125	7,450
Haywood.....	9	20	59	10,099	290	1,150	628	2,190	5,500	800	1,140	9,640
Henderson.....	7	13	23	5,910	535	1,350	4,710	12,250	4,950	300	285	18,850
Jackson.....	10	15	60	3,445	250	915	1,155	1,850	13,200	800	375	16,765
Macon.....	10	14	16	798	15	60	235	550	3,041	500	61	4,151
Madison.....	13	22	8	250	-----	-----	125	100	-----	-----	-----	100
McDowell.....	9	15	30	3,177	45	145	1,389	2,795	2,000	-----	77	4,950
Mitchell.....	10	15	11	2,164	2,570	1,175	33	250	125	1,025	35	2,575
Polk.....	5	11	26	3,935	415	1,300	3,557	810	3,500	6,250	850	11,860
Rutherford.....	8	18	28	1,630	78	280	70	540	200	-----	10	1,020
Surry.....	13	32	76	811	100	15,330	221	1,340	8,855	2,275	245	27,800
Swain.....	2	3	38	3,000	10	50	540	5,600	8,100	500	200	14,250
Transylvania.....	8	9	94	6,661	410	2,080	625	2,200	5,000	-----	1,002	9,280
Watauga.....	10	15	17	189	185	830	135	50,450	510	300	105	52,090
Wilkes.....	22	38	43	10,151	44	195	5,112	10,260	325	255	830	11,025
Yancey.....	9	17	14	1,031	413	1,660	70	250	1,200	200	92	3,310
Totals.....	208	367	759	66,173	9,628	38,820	24,003	110,860	80,033	23,470	7,654	253,183

TABLE 11.—FOREST FIRES IN NORTH CAROLINA DURING 1917

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Alamance.....	7	15	4	50	5	\$ 25	6	\$ 250	\$.....	\$ 300	\$ 100	\$ 575
Alexander.....	3	4	1	—	—	—	—	—	—	—	—	—
Cabarrus.....	8	10	2	9	—	—	9	208	515	—	107	723
Caswell.....	5	6	6	47	—	—	30	—	250	—	—	250
Catawba.....	7	11	—	—	—	—	—	—	—	—	—	—
Chatham.....	6	8	26	155	4	11	52	630	225	1,200	60	2,066
Cleveland.....	10	15	30	614	215	802	75	900	1,750	25	15	2,477
Davidson.....	12	22	31	200	52	285	101	870	850	1,400	252	2,405
Davie.....	7	12	6	53	10	50	40	75	65	630	—	820
Durham.....	3	4	—	—	—	—	—	—	—	—	—	—
Forsyth.....	9	12	6	80	50	250	50	400	550	—	20	200
Franklin.....	6	8	4	125	—	—	95	1,100	—	300	—	1,400
Gaston.....	5	7	11	40	4	200	40	150	350	—	—	700
Granville.....	6	8	14	556	—	—	26	650	—	—	25	650
Guilford.....	9	14	32	255	175	225	51	150	200	1,000	100	1,575
Iredell.....	6	9	8	26	6	40	3	50	160	25	5	275
Lee.....	4	7	13	—	—	—	—	—	—	—	—	—
Lincoln.....	5	10	—	—	—	—	—	—	—	—	—	—
Mecklenburg.....	13	18	7	13	20	100	8	60	200	—	—	—
Moore.....	8	13	38	1,925	110	1,140	1,765	7,210	500	250	170	9,100
Montgomery.....	8	17	40	2,515	35	150	1,625	4,837	—	600	45	5,587
Orange.....	4	5	8	4	—	—	4	60	—	—	—	60
Person.....	6	9	2	6	—	—	2	—	—	—	—	—
Randolph.....	15	23	40	1,388	204	317	763	1,590	1,800	1,700	170	5,407
Rockingham.....	8	11	16	17	6	75	—	—	—	25	—	100
Rowan.....	10	23	36	165	20	550	52	1,240	815	300	175	2,905
Stanly.....	7	11	24	38	18	80	17	58	610	40	67	788
Stokes.....	5	7	57	110	25	100	105	5,025	500	2,500	500	8,125
Union.....	6	8	8	310	—	—	300	1,010	725	800	500	2,535
Vance.....	7	8	10	1	—	—	—	—	150	—	—	150
Wake.....	7	8	11	57	—	—	25	600	900	350	—	1,850
Warren.....	9	11	84	1,052	1	45	474	3,400	2,000	500	200	5,945
Yadkin.....	8	12	30	—	—	—	21	150	100	—	10	250
Totals.....	239	366	605	9,819	960	4,445	5,739	30,673	13,215	11,945	2,521	56,918

TABLE 12.—FOREST FIRES IN NORTH CAROLINA DURING 1917

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Acres Young Growth Destroyed	Value Young Growth Destroyed	Value Products Destroyed	Value Improvements Destroyed	Cost of Fighting Fires	Total Damage Reported
Beaufort.....	2	4	2	30		\$		\$	\$	\$	\$	\$
Bertie.....	7	10	4	230	100	500	80	500	5,300	200	35	6,500
Bladen.....	10	12	16	9,875	5,435	12,175	2,075	2,125	14,700	1,000	580	29,990
Brunswick.....	2	3	2	275	5	25	10	100		200	15	325
Camden.....	2	3										
Carteret.....	1	2										
Chowan.....	1	1										
Columbus.....	10	14	83	8,490	857	1,923	3,775	10,450	20,465	8,400	1,475	41,238
Craven.....	2	5										
Cumberland.....	4	6	7									
Currituck.....	5	9	6	600		2,000	210	50				2,050
Dare.....	3	4										
Duplin.....	4	4	4	350	550	2,100	150	550	250		100	2,900
Edgecombe.....	9	12	13	336	202	610	312	3,200	75,000	10	5	78,820
Gates.....	2	2	1	5	10	30	5	50	30		10	110
Greene.....	5	6	4	20	5	20	10	300	400	100	100	820
Halifax.....	5	7	15	2,705	25	125	70	4,100	500	800		6,525
Harnett.....	8	11	23	1,852	5	15	347	725	350	150	12	1,240
Hertford.....	5	5	1	2		5						
Hoke.....	2	2	6	3,950	520	1,060			6,000	2	150	7,062
Hyde.....	3	7	8	100								
Johnston.....	10	14	41	650	60	300	515	2,705	2,800	5,200	500	11,005
Jones.....	4	4										
Lenoir.....	7	7	41	504	265	2,100	320	3,740	2,300	500	260	8,640
Martin.....	5	7	8	2,515	20	40	2,520	2,500	2,500	500	100	5,540
Nash.....	12	13	29	1,235	20	100	1,145	6,380	1,350		180	7,130
New Hanover.....	1	3	5	60			30	300				300
Northampton.....	4	5	1									
Onslow.....	4	5	26	1,700	150	600	1,100	2,300	200	100	250	3,200
Pamlico.....	3	4										
Pasquotank.....	5	6	1	2			2	50				50
Pender.....	7	9	11	10,005			10,005	60,025	50,000	10,000	2,025	125,025
Perquimans.....	2	2										
Pitt.....	9	11										
Richmond.....	7	10	58	3,210	235	450	400	2,295	2,050	3,000	175	7,795
Robeson.....	13	18	65	2,070	210	900	1,310	4,540	1,800	525	525	7,765
Sampson.....	8	10	4	710	75	117	700	5,525	1,600	50	110	7,292
Scotland.....	1	1	1	300			50	1,000				1,000
Tyrrell.....	3	4										
Washington.....	3	6	2									
Wayne.....	7	11	1	500	250	1,000	150	500	1,500	100	50	3,100
Wilson.....	3	4										
Totals.....	212	283	489	52,281	8,999	26,195	25,291	114,010	189,095	30,837	6,527	365,622

TABLE 13.—FOREST FIRES IN NORTH CAROLINA DURING 1917
COMPARATIVE STATEMENT OF AVERAGES BY REGIONS FOR 1917 AND FOR NINE YEARS

	MOUNTAIN		PIEDMONT		COASTAL PLAIN		STATE	
	1917	Average for 9 Years	1917	Average for 9 Years	1917	Average for 9 Years	1917	Average for 9 Years
Percentage of townships reporting	79	52	64	48	55	41	65	47
Average area of each fire, in acres	87	674	17	328	102	577	69	506
Average damage by each fire.....	\$ 457.00	\$1,076.00	\$ 103.00	\$ 590.00	\$ 736.00	\$1,178.00	\$ 367.00	\$ 950.00
Average area burned over per township reporting, in acres.....	317	*1,153	42	*516	245	*1,348	194	*919
Average damage per acre burnt ...	\$ 3.85	\$ 1.91	\$ 6.00	\$ 2.37	\$ 6.92	\$ 2.54	\$ 5.18	\$ 2.19
Average damage per township reporting.....	\$1,211.00	\$2,797.00	\$ 251.80	\$ 778.00	\$1,227.00	\$2,515.00	\$1,021.00	\$1,941.00

*Average for eight years; no township figures for 1909.

Even the fires of 1917 were not without their toll of life. The following is clipped from the *Charlotte Observer*:

YOUNG BOY KILLED BY FALLING TREE

"SALISBURY, May 29.—Everett Carrigan, 14-year-old son of Sam A. Carrigan, of Mill Bridge, Rowan County, is dead as a result of injuries received when a tree fell on him. The boy with other people was in a piece of woods where a fire had been burning, and when he went to push down a tree that had been partially burned it fell on him, badly mashing his back and otherwise injuring him so that he died."

The most notable thing in the forest fire figures for 1917 is the large increase in the number of fires, without, at the same time, increasing the total area burned over. As a matter of fact, a smaller area was burned over than in any previous year during which figures have been secured. This large increase in the number of fires is chiefly due to the reporting of small fires as well as large ones, in response to a change in the question blank. Nearly 30 per cent of the fires reported were Class A fires or those which covered less than one-fourth of an acre. Heretofore, most correspondents have considered such fires too unimportant to mention, so that the reporting of them is a new departure. Unless, therefore, allowance is made for this change the total number of fires is liable to appear out of all proportion to the seriousness of the fire season.

The gradual increase in the total damage per acre is very noticeable. This is due to the rapidly increasing value of the stumpage and of the products of the forest, as well as to the growing realization throughout the State that fire does a large amount of damage. Not only the township correspondents who send in the reports, but the landowners who suffer from fire, place an increasing value on the material destroyed. The landowner is recognizing his fire losses, and all over the State those who own land are anxious to prevent fires. There is, however, still a large element who are indifferent to fires, because they are not directly affected by them.

The average annual damage for each township reporting amounts to nearly \$2,000. This average applies to a steadily increasing proportion of the townships, with an average of one-half of them; though at the present time two-thirds of the townships have reported either fires or no fires. It is strange, when one comes to think of it, that an annual loss of \$2,000 per township passes unnoticed and no

complaint is made about it; whereas if that amount were added to the taxes of each township there would be nothing short of a revolution in North Carolina.

REVIEW OF THE PAST THREE YEARS

The figures published in Economic Paper No. 40, "Forest Fires in North Carolina During 1914," included the average figures extending over the previous six years. Comparison with those earlier estimates would now be, in many cases, misleading, because the basis upon which the data is compiled has been changed. With the transfer of the seven counties lying on the eastern slope of the Blue Ridge from the Piedmont to the Mountain region, a modification of the old classification has become necessary. Table 14 has, therefore, been prepared showing the total and average figures for the three-year period covered by this report. In future reports this summary will probably be used as the basis from which to work. In this table all figures relating to area and damage, which are in most cases of necessity only estimates of the individual local correspondents, are expressed for the sake of convenience in round numbers.

FOREST FIRES IN NORTH CAROLINA

TABLE 14.—FOREST FIRES IN NORTH CAROLINA
SUMMARY OF REPORTS FROM CORRESPONDENTS BY REGIONS FOR THE THREE YEARS 1915, 1916, AND 1917

	MOUNTAIN				PIEDMONT				COASTAL PLAIN				STATE			
	1915	1916	1917	Average for 3 Years	1915	1916	1917	Average for 3 Years	1915	1916	1917	Average for 3 Years	1915	1916	1917	Average for 3 Years
Total number townships in region	263	263	263	263	371	371	371	371	385	385	385	385	1,019	1,019	1,019	1,019
Number of townships reporting	177	197	208	194	190	215	239	215	185	240	212	212	621	652	659	621
Number of replies received	281	372	367	340	265	311	366	314	244	335	283	287	790	1,018	1,016	941
Number of forest fires reported	495	735	759	663	200	487	585	424	456	990	489	645	1,151	2,212	1,833	1,732
Total area burned over, in acres	176,000	189,000	66,000	144,000	31,000	73,000	10,000	38,000	205,000	715,000	52,000	324,000	412,000	977,000	128,000	506,000
Total standing timber destroyed, in M. ft. board measure	11,000	41,000	9,000	20,000	1,000	5,000	1,000	3,000	11,000	202,000	9,000	74,000	23,000	248,000	19,000	97,000
Value of timber destroyed	\$38,000	\$175,000	\$39,000	\$84,000	\$ 3,000	\$72,000	\$ 4,000	\$26,000	\$32,000	\$ 698,000	\$26,000	\$ 262,000	\$73,000	\$ 945,000	\$69,000	\$ 362,000
Area of young growth destroyed, in acres	100,000	54,000	24,000	59,000	19,000	34,000	6,000	20,000	107,000	390,000	25,000	174,000	226,000	478,000	55,000	253,000
Value of young growth destroyed	\$67,000	\$214,000	\$110,000	\$130,000	\$28,000	\$88,000	\$31,000	\$49,000	\$170,000	\$ 589,000	\$114,000	\$ 291,000	\$265,000	\$ 891,000	\$256,000	\$ 470,000
Value of forest products destroyed	44,000	182,000	80,000	102,000	8,000	109,000	13,000	43,000	31,000	1,131,000	189,000	450,000	83,000	1,422,000	282,000	595,000
Value of improvements destroyed	26,000	41,000	23,000	30,000	6,000	22,000	12,000	13,000	42,000	319,000	31,000	131,000	74,000	382,000	66,000	174,000
Total damage reported	175,000	612,000	253,000	347,000	45,000	291,000	60,000	132,000	275,000	2,737,000	360,000	1,124,000	495,000	3,640,000	673,000	1,603,000
Cost to private individuals to fight fires	12,000	16,000	8,000	36,000	1,000	5,000	2,000	3,000	4,000	36,000	7,000	16,000	17,000	57,000	17,000	31,000

The General Assembly of 1915 enacted a Forestry Law, said by the United States Forest Service to be one of the best State forest fire laws in the United States. At the same time, however, the appropriation designed to put this law into effect was cut out of the bill. The Legislature of 1917 likewise failed to make any provision for forest fire fighting, defeating a bill to provide an appropriation for this purpose, even after the total amount had been cut down to a meagre \$5,000 annually. If the State had been enabled to put the forest fire law into force there is no doubt that much of the \$3,640,000 loss of 1916 could have been prevented.

It is, however, in average fire seasons that the quickest effect of fire protective measures may be seen. The seasons of 1915 and 1917 were, if anything, below the average in fire risks, and yet the average damage by fires for these two years was practically the same as the average for the previous six years. If the appropriation of \$20,000 asked for had been made, it can hardly be doubted that the fire damage would have been reduced 25 to 50 per cent. It is estimated that \$17,000 was spent each of these years by private parties in fighting fires; if a similar amount had been spent by the State in trying to prevent them, much greater immediate as well as permanent results would have been obtained.

CAUSES OF FOREST FIRES

In order to simplify the reporting of the causes of forest fires, and at the same time to harmonize our reports with those made by the Federal Government relating to fires on the National Forests in this State, a new and somewhat shorter arrangement of causes has been made. This has necessitated the making of averages to cover only the past three years, or the period included in this report. As the results correspond almost exactly with the averages for the previous six years, practically no weight of evidence is lost. As a matter of fact, these figures are more accurate than those in previous reports, because in nearly all cases they refer to fires which actually occurred instead of embodying the opinion of the township correspondents as to what were the chief causes of forest fires in their townships.

TABLE 15.—CAUSES OF FOREST FIRES IN NORTH CAROLINA
AVERAGES FOR THE THREE YEARS 1915, 1916 AND 1917 IN PERCENTAGES

Causes	Mountain	Piedmont	Coastal Plain	State
Brush burning.....	28.0	38.0	21.0	28.0
Hunters.....	14.0	6.0	9.0	10.0
Campers.....	3.0	2.0	2.0	2.0
Railroads.....	13.0	22.0	18.0	17.0
Lumbering.....	11.0	11.0	16.0	13.0
Incendiary.....	6.0	2.0	6.0	5.0
Lightning.....	.5	1.0	1.5	1.0
Miscellaneous.....	2.0	5.0	5.0	4.0
Unknown.....	22.5	13.0	21.5	20.0

The most startling fact brought out by this table is the very large proportion of fires set by carelessly burning brush. These are nearly all set by farmers who own the land or by renters for whom the landowners are responsible. Thirty-eight per cent of the fires in the Piedmont region of the State are attributed to this cause alone, while taking the State as a whole, 28 per cent of the fires result from this

cause. The State law expressly says that all persons "who set fire to or burn any brush, grass, or other material whereby any property may be endangered or destroyed shall keep and maintain a careful and competent watchman in charge of said . . . brush or other material while burning. Fire escaping from such . . . brush or other material while burning shall be *prima facie* evidence of neglect of these provisions." This law is about as strong as it can be made, and yet practically no prosecutions have been made under it. This is because the State has been unable to appoint wardens to secure evidence and to bring such actions. To show that it can be done, however, the following account of a recent case is here given:

On the morning of April 6th a negro employee or renter on a farm not far from Black Mountain was preparing land to cultivate that had not been used for several years. He set fire to a pile of brush on the edge of some brushland, not more than 20 yards from the woods proper, when only he and his father were present. The fire escaped to the woods almost immediately, and the two men were unable to stop it, although they fought it until it was discovered by a Federal patrolman who had been appointed by the State Forester to coöperate with the Mount Mitchell Forest Protective Association in that region. The patrolman at once secured an automobile and reached the fire with four men by 10 o'clock. The fire was well under control by 2 o'clock, but owing to the very high wind and dry conditions, the men were kept on the job until late that night in order to be sure that everything was extinguished. One of the two negroes helped fight the fire throughout the day. About 20 acres of merchantable timberland and 30 acres of second-growth land was burned over, none of this having previously been burned. The damage was estimated at \$10 per acre, or a total of \$500. The men had not left the fire, because it got out almost immediately. The negro was prosecuted, however, because he had set fire on land without first notifying the adjoining property owners, and because he had not used proper precautions to prevent the spread of the fire. He submitted and confessed to setting the fire, and was convicted under section 8 of the Forestry Law. As this was his first offense, he was given the minimum fine of \$10 and costs, which was a sufficient warning to be more careful another time. A law which can be enforced against a negro should be equally effective against a white man or any one else who commits a similar offense.

Perhaps the second most striking feature of the above table is the small and decreasing percentage of incendiary fires. There were 6 per cent of such fires reported in 1915, 4.5 per cent in 1916, and 4 per cent in 1917. This, in one way, is a fine record, showing that the criminal desire to injure people by burning their woods is only present in isolated instances. On the other hand, however, it is an indictment of our people on their almost criminal carelessness. Ninety-five per cent of our fires are the result of carelessness, and could with proper precautions be prevented. Is it not time for the people, through their representatives in the Legislature, to take some definite and effective steps to prevent this overwhelming proportion of careless fires?

CLASSIFICATION OF FOREST FIRES

The question of control is one of the chief factors in determining whether the fire is a forest fire or not. The size of the fire does not enter into the question. A fire set in the leaves by the spark from a passing locomotive is a forest fire even though it only burns over a few square yards. On the other hand, a fire set pur-

posely to burn off a new-ground is not a forest fire even if it covers many acres, provided those who set it have taken adequate steps to keep it from going beyond the area which it was intended to burn and have succeeded in doing so.

The fire purposely set by the owner or agent of a tract of woodland, either to improve the range or to protect the larger timber, should not be reported as a forest fire, provided the land so burned is what was intended to be burned and no more, and provided the fire was at all times under the control of those who set it. On the other hand, a fire set on some one else's land without the consent of the owner, whether for the purpose of improving the range or with the object of injuring the owner, is a forest fire, and should be so reported. A camp-fire in the woods is not a forest fire, but if fire escapes from it and is at any time beyond the control of those who are present and allowing it to escape, it becomes a forest fire.

To assist forest officers and others in reporting on the causes of forest fires, the United States Forest Service has drawn up the following standard of classification, which is now used in all of its reports on forest fires. As this same classification is used, with only slight modifications, in this report, and will likewise be used in future reports, it is here printed in full. All voluntary correspondents, fire wardens, and patrolmen should study this classification carefully so that future reports may be as uniform as possible.

INSTRUCTIONS FOR REPORTING THE CAUSES OF FOREST FIRES

The standard classification used by the Forest Service for reporting the causes of forest fires is as follows:

LIGHTNING.—Fires the origin of which is directly traceable to lightning.

RAILROADS.—Fires incidental to the construction, operation, or maintenance of common carrier railroads. (This includes fires from sparks or cinders from all locomotive or construction engines, from lighted cigars, etc., thrown from car windows, from the clearing of rights of way, or from the individual carelessness of any employee or passenger.)

LUMBERING.—Fires incidental to all lumbering operations. (This includes fires caused by sawmill or donkey engines and logging railroad locomotives, except on such logging railroads as are common carriers; and by the carelessness of all lumbering employees.)

BRUSH BURNING.—Fires caused by clearing lands for any purpose (other than for rights of way for common carrier railroads, and brush burning in lumbering operations), or by rubbish, garbage, range, stubble, or meadow burning, and by burning out animals, insects, or reptiles.

CAMPERS.—Fires resulting in any manner from carelessness of campers, stockmen, prospectors, picnickers, surveyors, berry pickers, hunters, fishermen, automobilists, tramps, and other travelers through the forest. (In North Carolina we might add wagoners, and galax gatherers.)

INCENDIARY.—All fires maliciously set, regardless of whether or not they can be classified under one of the above heads.

MISCELLANEOUS.—All fires the origin of which is known, but which cannot be properly classified under any of the above heads.

UNKNOWN.—All fires the origin of which cannot be determined with such degree of certainty as would justify their inclusion under any other head.

According to the above classification, all fires caused by the carelessness of hunters are classed under "Campers," but those set by hunters to drive game either from a hollow tree or a thicket are classed under "Brush Burning." In Table 15 the fires caused by hunters must, therefore, be added to those attributed to campers to make the classification exactly tally with the Forest Service standard.

Regarding the causes of forest fires and the gratifying reduction in the number of fires in certain townships, the following comments and remarks will be of inter-

est. A correspondent in Wilkes County says: "More fires are caused by burning plant-beds and by night hunters than any other. We should have a law prohibiting careless night hunters carrying pine torches." The free ranging of live stock as an indirect cause of forest fires is referred to in two reports. A fire in Robeson County was attributed to "neighbor burning to graze a cow on the young grass"; while from Polk County, on the other hand, a correspondent writes that "Since we have had stock law, forest fires are a thing of the past. Before that, people would fire the woods, thinking that would make the grass grow for the stock." Another correspondent in Polk County says: "As a rule, the blockade distillers kept the woods burning in the spring to keep the smoke of their furnace from being discovered. Corn was so scarce, however, last year and prices so high that there was but small moonshine in operation." A correspondent from Madison County also mentions this cause of fire when he reports one: "Supposed to be started by illicit distillers." A small fire in Macon County was said to be started by "a match from the pipe of the mail man"; while one in Richmond County escaped from a burning tar-kiln.

That the citizens themselves are taking some interest in the matter is shown from reports from Wilkes County. "The damage by fire was small, owing to the wet or damp season and to the extra cautioning of sawmill men by some of the citizens. At one time last April we stopped the sawmills for a week or more. It got so dry we served notice on men who had new-grounds not to burn until it rained. It had a good effect. We are trying to get people educated to the danger of fire and how to handle it." A correspondent in another township of Wilkes County writes: "The citizens of our township are getting more careful with fire, and when fire breaks out they gather quickly to fight and subdue it before it gets great headway. If the winds do not fan the flames they can get it under control before great damage is done, but if very dry and windy there is very little chance to control it in this mountainous section without great damage. The laws should be more severe regarding careless burnings." Reports from three other Blue Ridge counties show a decided improvement in opinion and conditions. From Rutherford we hear: "Quite a number of our good citizens are awake on forest fires, and their influence is decidedly beneficial to our country"; from Polk County: "It seems that people have been more careful about fires during the last year"; while a Caldwell correspondent indorses the new Forestry Law as follows: "We had fewer fires last year than have ever been known in our township, due to the recent law against burning brush. That's a great law!"

PRESENT STATUS OF FOREST FIRE PREVENTION IN NORTH CAROLINA

STATE FOREST FIRE PREVENTION

Until the passage of the Forestry Law in 1915, little or no actual protection could be carried out, because there was no law that specially empowered the State Forester or any other official to do this work. Propaganda had been carried on by the State Geological and Economic Survey by means of publications, addresses, and correspondence, and this, of course, has been continued and enlarged.

THE STATE FOREST LAW

Since the passage of the Forest Fire Law (chapter 243, Public Laws of 1915) a new era has begun in spite of the fact that no money has been appropriated for carrying out its provisions. This law, in brief, provides:

1. That the State Geological and Economic Survey shall be charged with the duty of the prevention and control of forest fires in the State.
2. That the State Forester shall be State Forest Warden and shall administer the law, with the approval of the Geological Board.
3. That he shall appoint and have supervision of township and district forest wardens in such townships as he may deem necessary.
4. That these forest wardens shall, in their various districts, have charge of measures controlling forest fires, etc. That they shall be empowered to arrest offenders and to require outside assistance in fighting fires. They are to put up posters warning against forest fires, to be provided by the State Forester, and are to be supplied with suitable badges.

The law also strengthens the old Forest Fire Law, thus making it much more effective. According to this new law, it is unlawful to "set fire to any grass-land, brush-land, or woodland, except it be his own property, or, in that case, without first giving notice" to neighbors; and it is required that such fires must be watched while burning and "effectual care" taken to extinguish such fires before they reach the land of others. Wagoners, hunters, and campers are required to clear a space of ten feet surrounding their fire and to "fully extinguish" the fire before leaving it. Every one who burns brush, grass, or other material, or charcoal or tar-kilns, must watch such fire and absolutely prevent its escape.

Although no money has been made available for the enforcement of this law, the Survey, with the help of its own very limited funds, has done all it possibly could to carry out the letter and spirit of the law. The principal features of the work at the present time are the printing and distribution of posters, the appointment of State Forest Wardens, and the coöperation with the Federal Government and with local fire protective associations, in the appointment and direction of Federal patrolmen, and oversight of such associations.

POSTERS

Since the passage of the law and up to the present time (May, 1918) the Survey has had printed and distributed a thousand or more copies of each of the following posters warning against forest fires. The titles only of the placards are given here;

the rest of the reading matter usually consists of brief warnings and directions or passages from the forest law.

1. HELP! HELP!
THE COÖPERATION OF ALL GOOD CITIZENS IS
ASKED IN THE PREVENTION OF
FOREST FIRES
2. READ THE NEW LAW
FOR THE PREVENTION OF
FOREST FIRES
3. HUNTERS AND FISHERMEN
LOVE THE WOODS
THEREFORE
THEY WILL WANT TO ASSIST IN
PROTECTING THE WOODS FROM FIRE
4. ARE YOU
FARMING WITH FIRE?
5. CAMPERS AND WAGONERS
ARE REQUESTED TO
TAKE EVERY PRECAUTION
TO PREVENT FIRE ESCAPING FROM THEIR
CAMP-FIRES
6. HELP PROTECT OUR FORESTS!
7. SAFETY FIRST
8. THE STATE LAW
MAKES YOU RESPONSIBLE FOR THE FOREST FIRES
WHICH START THROUGH
YOUR CARELESSNESS
9. TO THE TRAVELING PUBLIC
BE PUBLIC SPIRITED
HELP PROTECT THE TREES, SHRUBS, AND FLOWERS ON
MOUNT MITCHELL STATE PARK
10. CUT WOOD
CUT WOOD
CUT MORE WOOD
THE TIME TO CUT IT IS RIGHT NOW

All the above posters are now out of print, but they are given in full in the Biennial Report of the State Geologist for 1915-1916, pages 52-58.

Posters 9 and 10 were issued for special purposes, but warnings against setting fire to the woods form an essential part of both of them.

11. FOREST FIRES ARE ALIEN ENEMIES
 I N T E R N T H E M !

12. O U R P A T R I O T I C D U T Y
 I S T O
 E L I M I N A T E A L L W A S T E
 F I R E I S T H E G R E A T E S T O F A L L W A S T E R S
 T H E R E F O R E
 P R E V E N T F O R E S T F I R E S

13. D O Y O U R B I T !
 H E L P K E E P F I R E S
 O U T O F T H E W O O D S

These last three posters have recently been distributed to forest wardens, patrolmen, and others who are interested in forest fires. They are available for distribution to any citizen of the State who will post them in conspicuous places, not only on his own land, but for the protection of all the land of the neighborhood.

As soon as these are used up, others will be printed and distributed as required. The following instructions for posting them are sent out with the posters:

"The new forestry law requires that the State Forester, as State Forest Warden, shall have posted 'along highways and in other conspicuous places copies of the forest-fire laws and warnings against fires.' The accompanying forest-fire notice may be posted in some conspicuous place, where the general public can see and read it.

"The most suitable places for such notices are along roads, especially at cross-roads, or on well-traveled trails in or near woodlands, in the country postoffice, and on the country-store door. The clerks of the court will be asked to post one on the bulletin board of each county courthouse.

"The forestry law also provides that 'Any person who shall maliciously or willfully destroy, deface, remove, or disfigure any sign, poster, or warning notice, posted by order of the State Forester, shall be guilty of a misdemeanor.' Any flagrant violation of this law should therefore be reported.

"The State Geological and Economic Survey will supply additional copies of this notice to those whose woodlands are in danger of being burnt, provided they can be posted effectively."

STATE FOREST WARDENS

Owing to the absence of funds, no township or district forest wardens to be paid and to act in accordance with the law can be appointed. However, through coöperation with the United States Forest Service and with associated landowners, patrolmen and wardens who are paid by the coöperators have in some cases been appointed State Forest Wardens. In every case special pains are taken to impress upon them the fact that no remuneration can be expected from the State.

Letter of Appointment:

The letters of appointment usually read somewhat as follows:

Date.....

Mr.....

Address.....

DEAR SIR:

Pursuant to the authority vested in me by the General Assembly of North Carolina, as set forth in Chapter 243, Public Laws of 1915, I hereby appoint you a Township Forest Warden in the Township of....., County of....., State of North Carolina.

You will please notify me by mail of your acceptance of this position, and at the earliest opportunity you will appear before a notary public, or other official competent to witness an oath, and swear before him to fulfill your duty as a Township Forest Warden according to the best of your ability.

The officer taking your oath will then sign a statement to that effect, which statement should be immediately forwarded to me.

The law under which you are appointed carries no appropriation. It must, therefore, be distinctly understood on your part that you are to receive no salary from the State and that your duties must be performed without cost to the State.

A copy of the State Forestry Laws, No..... badge, and a letter of instructions are being sent you herewith.

Very truly yours,

J. S. HOLMES,
State Forester.

Approved by the State Geological Board:

Signed: JOSEPH HYDE PRATT,

Director.

Oath of Office:

As soon as the Forest Warden receives his appointment he is required to swear to perform faithfully the duties of his office.

The following form is filled out by the notary or other State official in question and returned at once to the State Forester:

STATE OF NORTH CAROLINA

COUNTY OF..... } *Affidavit.*

Personally appeared before me,.....of..... County, North Carolina, who being by me duly sworn, deposes and says:

That he has been appointed Township Forest Warden, for.....Township,County, North Carolina, by J. S. Holmes, State Forester, and that he will, to the best of his ability, discharge the duties devolving upon him while filling this office, in accordance with the laws of North Carolina, known as the Forestry Law, as set out in Chapter 243, Public Laws 1915.

(Signed).....

Subscribed and sworn to before me, this.....day of.....191....

.....
Justice of the Peace.
Notary Public.

My commission expires.....191....

Letter of Instructions:

A letter of instructions is usually sent along with the appointment. These instructions vary to some extent according to the region in which the man is appointed and the special duties he is required to perform either as association patrolman, Federal patrolman, or other position which carries the salary upon which he lives. Besides these special instructions, general instructions are given him covering his special duties as a State Forest officer. These instructions are as follows:

Read Carefully!

Your duties as State Forest Warden must be carried out in strict accordance with the law (Chapter 243, Public Laws of 1915) under which you are appointed. You should immediately become familiar with this law, and especially with those parts of it (sections 4 and 6) dealing with your office and duties. Whatever work you undertake, however, it must be borne in mind that the State has provided no money with which to pay you or to fulfill any obligations incurred by you.

Concerning your duties as outlined in the Forestry Law, you will please observe the following directions:

(1) You are to take charge of measures controlling forest fires only in so far as this is compatible with the other duties which you are required to perform. Where the men are not paid by the State for fire fighting, but perform this service either free of charge or paid by other parties, the State cannot have the same complete control over them as if the State employed and paid them. You could, therefore, only take charge of such operations when it is the expressed wish of the fire fighters or their employers.

(2) You are allowed and required to make arrests without a warrant only when offenders are caught by you in the act of violating the Forestry Laws. Such an arrest should only be made when there is a big chance of the offender escaping if he is not arrested at once. In such case, for instance, as when the man is unknown to you or is a stranger in the neighborhood. In all other cases a warrant should be sworn out by you before a justice of the peace and served in the usual manner. It is much better for the law to take its usual course if the desired result can thus be obtained, namely, the ultimate arrest and conviction of offenders in order to deter them and others from similar offenses in the future. In other words, the power of arrest should only be exercised in cases of emergency; your duty is to prevent and extinguish forest fires. Let the magistrate and constables enforce the law in all cases where it is possible for them to do so; but where the offender would escape unless arrested at once, you should then use your power of arrest. When you make such arrest, you must "bring such person or persons forthwith before a justice of the peace or other officer having jurisdiction."

Do not hesitate to swear out a warrant against offenders, especially those who set fires purposely. You should, however, feel fairly sure that sufficient evidence can be secured to convict them of the offense. You should acquaint the State Forester with the result of all prosecutions in your district.

In dealing with first offenders against the Forestry Laws, it is, in nearly all cases, best to treat such with courtesy, explaining to them the points against which they have offended and warning them to be especially careful in the future. In most cases such a warning is sufficient to prevent a repetition of the offense; it is only in exceptional cases that it would be wise to arrest for the first offense. You must, however, use your own judgment as to which would have the best effect both upon the offender and upon the community in which you are working.

(3) Forest Wardens are required to "post along highways and in other conspicuous places copies of the Forest Fire Laws and warnings against fires." I hope you will be able to post some of these notices all over your district. I can send you those already printed by the State the supply of which is not exhausted and other notices that will be printed from time to time.

(4) The patrol work mentioned in section 4 cannot be undertaken as yet by the State on account of the lack of appropriation. Federal patrolmen and patrolmen employed by associations and landowners will, of course, carry on patrol work, but not immediately under the State requirements.

(5) Forest Wardens are required to make a report of each fire to the State Forester within ten days of such fire. You will be provided with printed forms upon which you can make such reports. To others than Federal patrolmen stamped envelopes will be sent for the purpose of mailing these fire reports; the Federal patrolmen can mail them in the franked envelopes in which they mail their ten-day time and weather report. Fires which are reported to you by District Forest Wardens or by Forest Fire Foremen appointed by the different associations should be reported by you to the State Forester on the same blanks. Each fire, however, must be reported on a separate sheet.

(6) The clause in section 6 providing for the summoning of "any male resident of the township between the ages of 18 and 45 years to assist in extinguishing fires" must

for the present be a dead letter on account of the lack of appropriation, unless a special fund for the payment of fire fighters can be made available in certain cases.

(7) The last clause in section 6 provides that "No action for trespass shall lie against any Forest Warden for crossing or working upon the lands of another in connection with his duties as Forest Warden." In view of this provision, you should be exceedingly careful not to injure property on which you work or travel. In the work of fire fighting which you will occasionally have to direct and take charge of, back-firing will occasionally be necessary. While back-firing is a legitimate and often the only way of fighting a serious fire, it should be done with care and judgment. A back fire carelessly or thoughtlessly set frequently does more damage than the original fire would do. In view of this fact, you should constantly bear in mind that fires injure the property upon which they burn and that, if you in back-firing needlessly burn over forest property, you are thereby needlessly destroying property. Nevertheless, this fact should not prevent you resorting to back-firing when in your judgment it is necessary.

(8) Section 7, providing for the compensation of Forest Wardens, is, of course, at the present inoperative.

(9) In enforcing the three sections of the law dealing with setting forest fires, namely, sections 8, 9, and 10, you should bear in mind that a warning given in time may perhaps save a serious offense against the law. Should you see a fire burning and one or more men in charge of it, a warning to them to see that the fire is entirely out before they leave it might save an offense and secure their future coöperation. It should be one of your first and most important duties to visit any legitimate burnings and let the people who are burning know exactly what the law requires. Hunters and other users of the forest should also be warned; they also should be watched as closely as possible until they leave the woods in your district.

Several of the provisions included in these three sections of the law are new or have been set forth in new terms. While ignorance of the law is no excuse for an offense under the law, it should be your care to see that every one who uses the forest, or who might become a menace to it in your district, is made acquainted with the provisions of the law.

(10) You are being provided with a badge of office. This badge should be worn at all times while on duty, in a position where it can be seen. It may be pinned on one side of the coat or shirt front, or at or near the belt. The badge should be carefully kept by you because, if lost, it might be found and misused by some one who has no right to it. The first badge will be sent you without cost, but, in case of loss, badges will have to be paid for by the Wardens.

To repeat the warning emphasized in my letter of appointment: the law under which you are appointed carries no appropriation. It must, therefore, be distinctly understood on your part that you are to receive no salary from the State and that your duties must be performed without cost to the State.

(Signed) J. S. HOLMES,

State Forester.

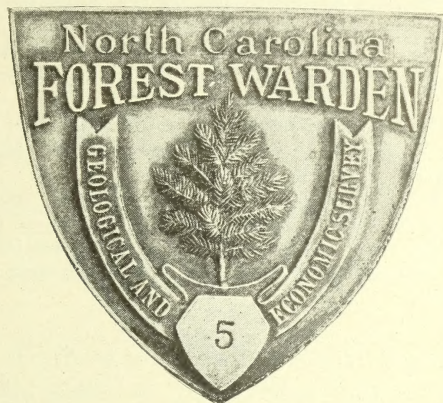
Badges:

Patrolmen and wardens are not appointed State wardens until they have proved their ability and reliability. The object is to have wardens who will, as far as possible, carry out the duties of their office without a show of force. When the case demands it, however, they must be ready to uphold the majesty of the law, though most of their work will be done through instruction and persuasion.

In order to increase their effectiveness, the Survey has had badges made which the State Forest Wardens are required to wear while on duty. These badges remain the property of the State, and if lost must be paid for by the warden. They are neat metal, shield-shaped badges, inscribed "North Carolina Forest Warden, Geological and Economic Survey," and are numbered from one up. The center of the badge shows a young shortleaf or rosemary pine tree designed from several photographs of young trees taken in the middle part of the State. The special significance of this design is:

(a) Pine trees supply the greater part of our timber. (b) The rosemary pine is distributed throughout the whole State and is our most important timber tree in

the Piedmont region. (c) The young tree represents the young forest which it is the special duty of the forest warden to protect. The cut of this badge is here given.



The following State Forest Wardens have been appointed:

J. E. DAUGHERTY, New Bern
JAMES F. BERRY, Tryon
E. R. GREENE, Blowing Rock
FRED MOSER, Black Mountain

D. L. MOSER, Black Mountain
GEORGE W. STEPP, Black Mountain
ED. T. SHEARER, Hayesville
U. A. MILLER, North Wilkesboro

These wardens have done excellent work in preventing forest fires. The very fact that a man wearing a badge is living in the neighborhood and may be in any part of the district at any time tends to make careful even the most careless. If a fund could be made available to pay men, even only for the time they actually expend in posting notices and patrolling during the driest and most dangerous weather, a vast amount of good would be accomplished. It is to be hoped that the next Legislature will make available a sufficient amount to secure the services of such men in all of the most important forest counties of the State.

COÖPERATIVE STATE WARDENS

Following the Sixth Annual Meeting of the North Carolina Forestry Association, held in New Bern, January 25 and 26, 1916, at which Mr. W. W. Ashe, of the United States Forest Service, strongly urged Eastern Carolina landowners to adopt some form of protection, the J. B. Blades Lumber Company of New Bern applied to the Survey for State assistance in protecting their lands from fire. In accordance with this request, the following proposition was made:

(1) That this company, together with two or more contiguous landowners in the same township or district, raise a fund for the payment of a forest warden and to meet the necessary expenses which he might incur in preventing and extinguishing forest fires.

(2) That this fund should not be less to start with than thirty dollars (\$30), and that the fund should be added to from time to time as previous payments became exhausted.

(3) That the money subscribed be paid direct to the North Carolina Geological and Economic Survey, to be drawn upon by the State Forester for the payment of the Forest Warden and others employed by him for services in connection with forest fire prevention and the extinguishment of forest fires.

(4) That the Forest Warden be nominated by the subscribing parties and approved by the State Forester.

(5) That his duties be, in general terms, those outlined in the Forest Fire Law (Chapter 243, Public Laws of 1915), he being under the control and direction of the State Forester.

(6) That it be distinctly understood that the Warden must do a certain amount of preventive work, such as posting notices, interviewing landowners, and, if possible, holding meetings in different parts of the township.

(7) That the Forest Warden cannot receive compensation for services or expenses in excess of the amount previously deposited with the Survey by the coöperators, and that the State accepts no responsibility for debts incurred by the Forest Warden or others in the performance of their duty beyond the amount subscribed and already paid in by the coöperators.

Appointment of a Forest Warden.—The above conditions were met by the four following landowners in Township No. 9, Craven County: the J. B. Blades Lumber Company, the Broadus and Ives Lumber Company, the Pine Lumber Company, and Munger & Bennett; and on May 16, 1916, Mr. J. E. Daugherty of New Bern, N. C., was appointed Township Forest Warden. In making the appointment, the State Forester called the attention of the warden to the following points:

(a) Your duties are specified in the law (Chapter 243, Public Laws of 1915) under which you are appointed.

(b) You are to be paid, in accordance with the law, not to exceed 20 cents per hour or \$2 per day for the actual time given to the work. The sum of forty dollars (\$40) has been deposited with the State Forester by the coöperators for the payment of necessary expenses incurred by you. Assurances have been made by the coöperators that further money will be available for your use when it shall be required. Signed statements of expenditures must be forwarded to the State Forester by you or by the coöperators for the payment of necessary expenses incurred by you. Assurances have been made by the coöperators that further money will be available for your use when it shall be required. Signed statements of expenditures must be forwarded to the State Forester at the end of each month, as the law requires.

(c) You should make arrangements with suitable parties in different parts of your district to notify you, by telephone or otherwise, of the occurrence of any fires as soon as they are discovered, and, if you think advisable, give directions to certain parties to start fighting the fires, pending your arrival upon the scene.

(d) All rural mail carriers are required to report fires to the proper authorities. You will, therefore, arrange with such carriers in your district to report fires to you upon discovery.

(e) The watching of burning logs, stumps, etc., after a fire has been controlled, is an important part of fire protection; therefore, the employment of assistants to watch such danger spots is a legitimate expense.

(f) You should immediately become familiar with the Forest Fire Law, and especially with sections 4 and 6, which deal especially with the duties of your office.

The State Forester is prepared to enter into a similar arrangement with other parties anxious to make more effective their fire protective work, or with township or county officials who wish to secure the assistance of the State in fire prevention. As soon as a State appropriation is secured it is hoped that counties or townships will see their way to coöperate on equal terms with the State in the employment of forest wardens.

FEDERAL FIRE PREVENTION IN NORTH CAROLINA

The Federal Government is doing its full part in helping to protect the forests of this State from fire. This work is being done through two different agencies, the National Forests Administration and Federal coöperation with the State.

NATIONAL FORESTS

Through the operation of the Weeks Law, which was enacted by Congress in 1911, the Government has purchased mountain forest land in a number of the western counties of North Carolina with the avowed object of protecting the headwaters of streams. At the present time the Government has approved for purchase and is administering some 319,000 acres, distributed as follows:

LOCATION AND AREA OF NATIONAL FORESTS IN NORTH CAROLINA

<i>Name of National Forest Area</i>	<i>Counties in Which Located</i>	<i>Total Area March 30, 1918</i>
Pisgah.....	Buncombe.....	88,194
	Henderson.....	
	Transylvania.....	
	Haywood.....	
Mount Mitchell.....	Yancey.....	75,130
	Buncombe.....	
	McDowell.....	
Nantahala.....	Macon.....	72,672
	Swain.....	
Boone.....	Avery.....	45,830
	Caldwell.....	
	Burke.....	
Savannah.....	Macon.....	37,272
	Jackson.....	
	Total.....	319,098

One of the chief duties of the forest officers who look after and patrol those forests is the prevention and extinguishment of fires, and although much of the area is quite remote and some is subject to extreme fire risks from railroad and logging operations, the fire damage has been kept down to a most encouraging extent. This was referred to in Economic Paper No. 40, pages 14 to 17. The loss from forest fires on and near the National Forests was greater in 1917 than in any previous year since their purchase, yet the percentage of area burned over was only about one-half that for the entire mountain region as reported to the State Forester. A summary of the annual fire reports for 1917 of the two forest supervisors in charge of the National Forests located in North Carolina is given below, with the idea of showing the care and accuracy with which these forest fires are reported. As soon as the State is enabled to organize its Forest Warden force, it is planned to adopt methods of reporting fires as close as possible to that already being practiced by the Federal Government in this State.

TABLE 16.—SUPERVISOR'S ANNUAL FIRE REPORT FOR THE CALENDAR YEAR 1917
PISGAH, BOONE, MOUNT MITCHELL, NANTAHALA, AND PORTION OF SAVANNAH NATIONAL FOREST

	A. Under ¼ Acre	B. Under 10 Acres	C. Over 10 Acres			Total
			1. Damage Under \$100	2. Damage \$100- \$1,000	3. Damage Over \$1,000	
1. Fires originating on National forest lands.....	10	20	18	2	1	51
2. Fires originating on private lands inside National forest boundaries.....		1	7	2		10
3. Fires originating outside of National forest boundaries which enter forests.....	1	1	1	1		4
4. Fires originating outside of National forest boundaries which do not enter forests.....		1	3			4
Totals.....	11	23	29	5	1	69

	Railroad	Light- ning	Incen- diary	Brush Burning	Campers	Lum- bering	Un- known	Miscel- laneous	Total
5. Causes of all fires reported.....	4		4	4		35	17	5	69

6. DAMAGE FROM FIRES WITHIN NATIONAL FOREST BOUNDARIES

Location of Fires	Area Burned Over			Damage to Timber, Reproduction, and Forage*				
	Tim- bered, Acres	Open Acres	Total Acres	Timber Destroyed or Damaged		Repro- duction Value	Forage Value	Total Value
				M B. F.	Value			
On National forest lands.....	2,316		2,316	25 M	\$ 100	\$ 1,130	\$ 75	\$ 1,385
On private lands inside National forest boundaries.....	2,211		2,211	20 M	80	*The amount and value of damaged cordwood may be included with the timber on the ratio of 1 cord=500 B. F.		
Totals.....	4,527		4,527	45 M	180			

7. COST OF FIGHTING ALL FIRES

Division of Cost	Temporary Labor	Guard and Ranger Labor	Tools, Supplies, Trans- portation, Etc.	Total Cost	Value of Co- operation
On National forest lands.....	\$ 350.96	\$ 105.87	\$ 48.47	\$ 505.30	\$ 139.65
On private lands inside National forest boundaries....	143.64	25.69	7.71	177.04	37.80
Outside National forest boundaries.....	52.28	9.44	15.65	77.37	10.00
Totals.....	546.88	141.00	71.83	759.71	187.45

WEEKS LAW COÖPERATION

Under the second section of the Weeks Law the United States Department of Agriculture is empowered to coöperate with States in organizing and carrying out fire prevention on other than Federal lands. (See Economic Paper No. 33, pages 31 to 48.) This section reads as follows:

SECTION 2. That the sum of two hundred thousand dollars is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, to enable the Secretary of Agriculture to coöperate with any state or group of states, when requested to do so, in the protection from fire of the forested watersheds of navigable streams; and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any state or group of states to coöperate in the organization and maintenance of a system of fire protection on any private or state forest lands within such state or states and situated upon the watershed of a navigable river: *Provided*, that no such stipulation or agreement shall be made with any state which has not provided by law for a system of forest fire protection: *Provided further*, that in no case shall the amount expended in any state exceed in any fiscal year the amount appropriated by that state for the same purpose during the same fiscal year.

(Act of March 1, 1911.)

Policy and Methods of the United States Forest Service:

General Service Policy.—The most important objects of expenditures under section 2 of the Weeks Law are (1) to promote forest fire protection by states, counties, and associations of owners, and (2) to develop closer coöperation among various agencies engaged in protective work and weld more or less scattered efforts into an efficient, organized system. The accomplishment of these objects must govern primarily the use of Weeks Law funds, particularly while the amount available is so small. This policy will be applied particularly in providing, first, for the needs of States whose resources are limited or in which general and efficient fire protection has not yet been developed. It will be applied also through Federal participation in fire protective work where such participation, even on a limited scale, will aid in cementing the activities of existing public and private agencies and bringing about a better organized and more efficient protective system.

While the foregoing features of the work must receive the greatest emphasis, particularly in the allotment of funds, the Government recognizes an obligation to participate permanently in the protection of the watersheds of navigable streams. The passage of the Weeks Law recognizes the duty of the Federal Government to aid in preserving the navigability of important streams through the protection of their watersheds; and hence that the Government is justified in assuming a definite part of the cost. It is the position of the Service that the solution of the national problem of protection from forest fires requires the continued participation of the Federal Government; and that the enormous public interests involved in the protection of forest and water resources will not permit the Government to withdraw from this work after a brief period of educational effort. While, therefore, greatly enlarged appropriations are unnecessary and not anticipated, it is the policy of the Government to continue this work permanently, if on a small scale, as an active associate of the states and private owners. As far as the funds are available after providing for work in states where its purpose is primarily educational, the Service will thus continue to coöperate with other states, even if the other agencies

in such states would be able if left to themselves to provide sufficient funds for fire protection under ordinary conditions. The value of Federal coöperation as a means of cementing and improving the protective work in such states is an ample justification for these expenditures, aside from the obligation resting upon the Government to aid in the protection of navigation.

Lands Protected.—The first requirement of the Weeks Law is that the protection shall be confined to the forested watersheds of navigable streams. At first coöperation was restricted to the headwaters of streams which are navigable for interstate trade. More recently the Solicitor of the Department gave it as his opinion that "all streams which are adaptable in the particular locality to the floating or transportation of the products of that locality" are navigable, which definition is the present basis for determining the limits of the coöperative areas.

State Protective System.—The second requirement of the law is that the State must have "provided by law for a system of fire protection." This proviso, at first very strictly construed, has, under more recent opinions from the Solicitor's office, been interpreted as meaning any system of protection, including the employment of men for patrol, lookout or fire-fighting purposes, or the adoption of other protective measures under the authority of any State law, whether or not the law actually specified the protective system which should be employed. A scheme of fire protection initiated by a state forester under the general authority of forestry laws of the state is thus regarded as sufficient to satisfy the requirement.

State Appropriation.—The third proviso is that the state must appropriate for fire protective purposes during the same Federal fiscal year an amount at least equal to that expended by the Federal Government. At first this was construed strictly to require a definite appropriation for fire protection work or an allotment for the purpose from a lump-sum forestry appropriation. Subsequently any expenditure made by any authorized state agency which has for its object the encouragement and furtherance of fire protection work has been accepted as fulfilling this requirement. Thus, in both Virginia and North Carolina no appropriation is made for the maintenance of a forest fire protective system. But the portion of the salary and expenses of the State Forester or clerk which is devoted to forest fire propaganda and the organization of a voluntary field force is considered an appropriation within the meaning of the Weeks Law. Any State funds used for the broad purpose of fire protection, including overhead expenses for administration, fire-fighting funds, expenditures for publicity work, etc., may be included in the amount required to offset the Federal allotment.

Federal Allotments and Expenditures.—Allotments are made by the calendar year for the full fire season or seasons. This makes it possible for the states to know before the beginning of the season the amounts they are to receive for the full danger period, and they can then plan accordingly, which would not be the case if the allotments were made by the Federal fiscal year.

Federal expenditures cannot exceed the amount appropriated by the State. This has been construed simply as stipulating a maximum limit for Federal expenditures, not as providing for an equal division of forest fire expenditures with any state with which we may coöperate. This is obviously the only possible construction, for some of the states expend each year as much as the entire Federal appropriation. In coöperating with a state whose total funds available for fire protection amount to \$5,000 or less, however, in most instances an equal allotment from Weeks Law funds has been made.

In making allotments to states appropriating more than \$5,000, the aim is to make the Federal allotment such that with the state and private funds available the coöperative area may receive as nearly as possible adequate protection under ordinary conditions of hazard and risk.

State's Responsibility.—The State is held to be responsible for organizing, administering, and maintaining the efficiency of the fire protection system, including the work of the Federal men hired under the Weeks Law. The State's interest in the protection of its forests as a property, whether in State or private ownership, is tangible and direct, while that of the Federal Government is more or less indirect through their influence on watershed protection. The Service is desirous of doing everything in its power to encourage the states to recognize and assume their responsibility for this protection.

Federal Responsibility.—That the Federal Government has a definite responsibility in the protection of watersheds of navigable streams, however, is clear, although it was deemed by Congress insufficient to justify the Government in assuming a share of the cost greater than that borne by any particular state.

Use of Federal Allotment.—The expenditure of Weeks Law funds is restricted as closely as practicable to the salaries of lookout watchmen and patrolmen.

It is to be understood, of course, that in periods when the discharge of their regular duties is unnecessary, men employed for patrol or lookouts may and should be used for the construction of improvements, disposal of slash, or any other fire protective work which the State organization has in mind. If, however, the regular patrol season closes with a portion of the allotment unexpended, it may be desirable to authorize the State to use such balance for slash disposal, permanent improvements, and like protective work, these expenditures bearing the same proportion to those of the State as the expenditures for patrols and lookouts. Arrangements of this character may be authorized by the Forester.

Fire Plans.—Every reasonable effort has been made to get the states to prepare fire plans, with maps showing improvements, equipment, and the disposition of the forest fire personnel, supplemented by written descriptions of the control organization and control measures to be taken.

Private Efforts.—One of the cardinal features of Weeks Law coöperation is to secure the participation of private owners. One of the conditions required of the states is that they shall secure a reasonable amount of assistance from the private owners in coöperative areas. The State is called upon to indicate in its yearly budget the funds which will be furnished from private sources; and the extent of such aid will be one of the factors considered in determining the allotment to the State. Weeks Law agreements are not three-cornered, however. The Service deals only with the State, and the latter is responsible to the Service for securing adequate private help. The Service will, of course, aid the State in any ways found practicable in enlisting the interest and support of private owners, forming protective associations, etc.

State Reports.—A report from the State is required at the end of each calendar year. It has been our aim to reduce this report to the briefest form possible. A tabular statement giving number of fires by areas; damage and cause; loss by fires; and summary of State appropriation and expenditures for fire protection forms Part I of the report. Part II comprises a discussion in such detail as seems necessary of the following subjects:

1. Character of the fire season.
2. Character and amount (funds, labor and material) of assistance rendered by
 - a. Private landowners (individuals or through associations);
 - b. Railroads;
 - c. Rural mail carriers.

Federal Patrolmen:

After the passage of the State Forestry Law in 1915, the State Geologist entered into an agreement with the United States Department of Agriculture whereby the Survey was enabled to appoint a few Federal patrolmen to coöperate with the private landowners in the various parts of the State. A copy of the agreement is given in the Biennial Report of the State Geologist for 1915-16, pages 34 to 37. This agreement provides that a sum not to exceed \$2,000 will be apportioned to North Carolina for the purpose of employing patrolmen or lookouts, provided the expenditures of the State for fire prevention equals or exceeds the amount spent by the Government. All expenditures of the Survey made for preventing forest fires, including such part of the salary and office and field expenses of the State Forester as was made for that purpose, may be counted as the State's proportion.

The first Federal patrolman to receive an appointment in North Carolina under the Weeks Law agreement was John Riis. He was appointed in Tryon Township, Polk County, October 1, 1915. The following statement shows the men employed up to January 1, 1918, and the duration of their employment for each fire season:

Fall Season, 1915:

<i>Name.</i>	<i>District.</i>	<i>Duration of Appointment.</i>
John Riis.....	Tryon	October 1 to December 18
Anderson McFalls.....	Mount Mitchell	October 1 to December 15
G. W. Stepp.....	Black Mountain	November 1 to December 15

Spring Season, 1916:

John Riis	Tryon	March 10 to May 31
G. W. Stepp.....	Black Mountain	March 10 to May 27
Anderson McFalls	Mount Mitchell	March 22 to May 27
C. D. Cannon.....	Blowing Rock	March 29 to May 27

Fall Season, 1916:

J. Hilliard Metcalf	Tryon	November 2 to December 15
Frank Icenhour	Blowing Rock	November 21 to December 15

Spring Season, 1917:

Frank Icenhour	Blowing Rock	April 2 to June 15
James F. Berry.....	Tryon	April 2 to June 12
G. W. Stepp.....	Black Mountain	April 12 to May 27

Fall Season, 1917:

D. L. Moser.....	Mount Mitchell	October 4 to December 7
G. W. Stepp.....	Black Mountain	November 5 to December 7
James F. Berry.....	Tryon	November 7 to December 7
E. R. Greene.....	Blowing Rock	November 1 to December 7

These men were appointed to coöperate with associations and landowners who were organized for the purpose of forest protection. Other appointments would have been made but for the difficulty of securing the coöperation of landowners, many of whom were willing to coöperate themselves, but could not secure the active coöperation of adjoining landowners. It was this difficulty which has caused the

discrepancy in the apparent expenditures of the State and of the Government. These expenditures are summarized for the three years as follows:

	<i>State Expenditures</i>	<i>Federal Expenditures</i>
1915.....	\$1,707.35	\$379.33
1916.....	1,068.49	699.67
1917.....	1,137.00	657.66

It must be here explained that the large predominance of State expenditures over Federal ones is in no way the fault of the Federal Government, but is entirely due to the indifference and lack of response on the part of the landowners of North Carolina. Many efforts were made by the State Forester to organize coöperative fire prevention in order to be enabled to appoint Federal patrolmen, but little active interest could be secured outside of the three associations elsewhere alluded to in this report.

Starting with 1918, however, a new offer has been made to the people of the State, and two additional patrolmen have been appointed under this new arrangement. The idea is to appoint Federal patrolmen to much larger districts to travel over these large areas, posting notices, interviewing landowners and others, and endeavoring to so interest the people in forest protection as to gradually work up more active and effective coöperation.

Patrolmen will be appointed only for the spring and fall danger seasons. The former usually begins in March or April and lasts from six to ten weeks, while the latter commences the latter part of October or the beginning of November and continues up to the first or second week in December.

Patrol Districts:

The districts are selected with the view of doing the greatest amount of good. Counties where the people are thoroughly interested are more likely to be selected than where the landowners are indifferent or antagonistic, because better results can be secured. A county where forest fires are actually being prevented will serve as an incentive and example to all surrounding counties.

Each man is assigned a definite district to cover, either on horseback, in a buggy or a Ford, or on foot, the size of each district varying according to local conditions. Districts are selected according to the importance of fire protection, and the boundaries are established with reference to topographic rather than political features. These districts are more or less arbitrary and are changed from one period to another, as is found to be necessary. The patrolman's headquarters are preferably as near the center of his district as possible.

Federal Regulations:

Federal patrolmen are appointed by the State Forester in his capacity as collaborator in the United States Department of Agriculture; they are, therefore, Government employees and subject to Federal regulation and discipline. The following regulations will be of interest to the general public, as affecting these public servants:

QUALIFICATIONS.—Certain qualifications are essential in selecting a patrolman. To begin with, the Federal Government *insists* that he must be selected on merit, without regard to any personal or political considerations whatever. He must be a man of intelligence, dependability, and sobriety. He must further be thoroughly

familiar with the territory in his district, as he is required to traverse all sections of it at regular and repeated intervals. Since his is an arduous duty, demanding almost continuous horseback travel, he must be physically able to perform it. He must be tactful in his dealings with people in his district; and, finally, he must be the type of man who is well regarded in his own community.

The Government some time since sent out the following order:

Qualifications for Federal Men Employed Under the Weeks Law.—Candidates for appointment as temporary employees during the season of serious danger from fire must be able-bodied and capable of enduring hardships and of performing severe labor under trying conditions; must be able to build trails and cabins and to pack-in provisions without assistance; must be thoroughly familiar with the region in which they seek employment (or other similar regions), including its geography, its forests, and industrial conditions.

Invalids and consumptives seeking light out-of-door employment are not qualified for the work, and should not be employed.

Employing officers will require sobriety, industry, physical ability, and effectiveness; will give preference to local residents of whose fitness he is fully satisfied, and will employ no person for personal or political consideration.

Political Activity Prohibited.—The orders prohibiting political activity, which follow, will be strictly enforced.

POLITICAL ACTIVITY.—Rule 1, section 1, of the Civil Service Rules reads as follows:

No person in the executive civil service shall use his official authority or influence for the purpose of interfering with an election or affecting the result thereof. Persons who by the provisions of these rules are in the competitive classified service, while retaining the right to vote as they please and to express privately their opinions on all political subjects, shall take no active part in political management or in political campaigns.

The first sentence of the rule applies to every person in the executive civil service, irrespective of the method of his appointment. The second sentence of the rule applies to all persons holding positions in the competitive classified service, whether the appointment be permanent or temporary in character, and by departmental action has also generally been made applicable to unclassified laborers (lookout watchmen and patrolmen under the Weeks Law).

The following forms of activity have been held to be forbidden by this provision:

Service on political committees; service as delegates to state, county, or district conventions of a political party, although it was understood that the employees were not "to take or use any political activity in going to these conventions or otherwise violate the civil service rules;" service as officer of a political club, as chairman of a political meeting, or a secretary of an anti-saloon league; continued political activity and leadership, activity at the polls on election day; the publication or editing of a newspaper in the interests of a political party; the publication of political articles bearing on qualifications of different candidates; the distribution of political literature; holding office in a club which takes an active part in political campaigns or management; making speeches before political meetings or clubs; activity in local option campaigns; circulation of petitions having a political object, of petitions proposing amendments to municipal charter, of petitions favoring candidates for municipal offices, and of local option petitions; candidacy for or holding of elective office; accepting nomination for political office with the intention of resigning from the competitive service if elected; recommendation by clerks and carriers of a person to be postmaster; service as a commissioner of election in a community where it was notorious that a commissioner of election must be an active politician; service as inspector of election, ballot clerk, ballot inspector, judge of election, or member of election board; or generally any form of activity in political management or political campaigns, though not specifically mentioned above.

In as much as the issuance of a certificate for reinstatement is discretionary with the Civil Service Commission, no certificate will be issued in any case where the party applying for reinstatement has previously resigned with a view of running for office, or with a view of indulging in a degree of political activity which would be prohibited if he had remained in the service, and who afterwards, having failed in his candidacy or having indulged in the contemplated activity, seeks reinstatement.

POLITICAL ASSESSMENTS OR CONTRIBUTIONS.—The civil service act (22 Stat., 404) provides that "No person in the public service is for that reason under any obligations to contribute to any political fund, or to render any political service, and . . . he will not be removed or otherwise prejudiced for refusing to do so." Section 118 of the Criminal Code provides that no Federal officer or employee shall, directly or indirectly, solicit or receive, or be in any manner concerned in soliciting or receiving any political assessment, subscription, or contribution from any other Federal officer or employee. Section 120 of the Criminal Code prohibits the discharge, promotion, or degrading of any officer or employee for giving or failing to make any political contribution. Section 121 of the Criminal Code prohibits any Federal officer or employee from making any such political contribution to another Federal officer or employee, and section 119 prohibits the solicitation or receipt of any political contribution in any room or building occupied in the discharge of official duties by any officer or employee of the United States, or on other Federal premises by any person whatsoever, whether in the public service or not. In connection with this latter provision, the United States Supreme Court has held that a solicitation by letter or circular addressed and delivered by mail or otherwise to an officer or employee of the United States at the office or building in which he is employed in the discharge of his official duties is a solicitation within the meaning of the law, the solicitation taking place where the letter was received. Section 122 of the Criminal Code provides that whoever shall violate any provision of the four sections above mentioned shall be fined not more than \$5,000 or imprisoned not more than three years, or both.

It is the duty of the Civil Service Commission to see that the civil service act and rules and the above-mentioned sections of the Criminal Code, which were originally enacted as a part of the civil service act, are strictly enforced, and it will employ every legitimate and available means to secure the prosecution and punishment of persons who may violate them. The Commission requests any persons having knowledge of any such violation to lay the facts before it, that it may at once take action thereon.

—From "*National Forest Manual*," pages 17A-18A.

In regard to the above, the United States Forester writes:

"I confidently expect that all members of the Service will perform their duties uninfluenced by any political consideration, and will not knowingly violate the law or regulations, or the proprieties."

COMPENSATION FOR INJURIES TO FEDERAL EMPLOYEES.—The following paragraphs are quoted from circular-letters sent out by the United States Forester, September, 1917. These circulars describe the necessary procedure in securing treatment under the Federal Compensation Act of September 7, 1916, for injuries received by employees of the United States while in the performance of their duties:

"When civil employees of the United States are injured while in the performance of their duties they are, by the terms of the Federal Compensation Act of September 7, 1916, entitled to 'reasonable medical, surgical, and hospital services and supplies' for the injury, whether or not disability has arisen.

"In addition to necessary medical, surgical, and hospital expenses, if the injury results in disability for more than three days, compensation is payable at the rate of two-thirds of the monthly pay, beginning with the fourth day from the cessation of the regular compensation, but cannot exceed \$66.67 a month. Any annual or sick leave due may be used in preference to compensation under the Compensation Act. No compensation is payable if the injury is caused by willful misconduct of the injured employee, his intention to bring about the injury, or his intoxication.

"Every employee sustaining an injury should immediately seek first-aid treatment, no matter how slight the injury, many slight injuries having serious consequences through failure to receive prompt attention.

"The following forms are used in the administration of this act: Form C. A. 1, *Notice of Injury* (to be made by the injured employee or his personal representative to his official superior); Forms C. A. 2, *Report of Injury* (to be made by the official superior); Form C. A. 3, *Report of Termination of Disability* (to be made by the official superior); Form C. A. 4, *Claim for Complete or Partial Disability*, and Form C. A. 5, *Death Claim*. The Compensation Commission is unable to supply these forms in sufficient quantities for advance distribution to all field stations. Any employee injured in the course of his employment should at once notify his official superior and call for a blank form upon which to make the written report required by the law. If he is unable to attend to this himself, it should be done by some one else in his behalf. This report should be made for every injury, however slight. The various report forms will be furnished from the office of the Collaborator (The State Forester, Chapel Hill, N. C.) as required.

"The benefits of the Federal Compensation Act extend only to persons on the pay rolls of the United States and *do not apply to State employees* even if engaged in similar employment under the direction of this office."

Appointment of Federal Patrolmen:

The letter from the State Forester appointing a Federal patrolman endeavors to specify clearly what is expected of him as a Federal officer. It usually follows the form here given:

DEAR MR.....:

(1) Under the authority delegated to me in the Agreement for the Protection from Fire of the Forested Watersheds of Navigable Streams between the North Carolina Geological Board and the Secretary of Agriculture of the United States, signed March 11, 1916, I hereby appoint you a Federal patrolman, to act in that capacity in North Carolina as long as this appointment shall last.

(2) You will be paid at the rate of.....per.....by the Federal Government from the time your appointment commences until it terminates. Upon submission of your last time report for each calendar month, the pay roll, with your name upon it, will be forwarded by me to the Washington office, and you will receive your salary check direct.

(3) Your appointment will begin..... and will continue without interruption until, in my opinion, the.....forest fire season is over.

(4) Your headquarters will, until further notice, be at.....

(5) Your district comprises.....(describing district).

(6) Your patrol routes must be arranged by you in order to best cover the district under your charge. While having some definite patrol routes, it will be best to vary them from day to day. You are expected to keep a horse and ride him regularly.

(7) When you discover a small fire burning, it is your duty to extinguish it; try to get neighboring residents to extinguish larger fires. Your own judgment will determine whether or not it is practicable to extinguish the fires found burning. It is important, however, to build up in different communities a spirit which in the future will lead to the extinguishing of all fires by local residents. Once there is a sentiment against fires, fewer fires will occur and persons will more readily extinguish those which do occur.

(8) *Lumbering operations* and *portable sawmills* within your district must be visited frequently and the owners and operatives warned to be careful. A copy of the State law should be in the hands of every sawmill man. *Farmers clearing land* and likely to be burning brush should be visited and warned to burn only in strict accordance with the law. Fishermen, hunters, and campers must be interviewed and made to understand why it is to their advantage to prevent fires. (This paragraph usually enumerates the different important fire risks in the district. These usually include railroads, logging operations, and other activities in the woods, such as tie-cutting, tar-making, or charcoal burning.)

(9) During the time when patrol is not necessary, that is, immediately after rains or during wet spells, you should either (a) busy yourself with the construction of improvements which will make protection more complete, such as extending or repairing telephone lines or making or improving trails, or constructing fire lines, (b) take the opportunity of visiting remote or outlying districts and posting notices and interviewing residents there.

(10) You may later be appointed a State Township Forest Warden, under the State law, with authority to enforce the State laws. Special instructions would then be sent you with your appointment, and you would be furnished with a badge which you would be expected to wear when on duty.

(11) (This paragraph usually enumerates the different persons, corporations or associations with which coöperation should be carried on or encouraged, such, for instance, as the forest protective associations, railroad companies, city waterworks, lumber companies, farmers and other landowners.)

(12) You are being supplied with fire notices printed by the State, which you can post in conspicuous places, wherever you think they will do good. A number of copies of the State Forestry Law are also being sent you; these are to be distributed to those who are interested, while the law should be explained to all.

(13) Arrangements should be made with telephone companies for the immediate reporting of fires at special rates or free of charge. Private lines should be utilized and extended as much as possible.

(14) In accordance with the instructions of the Postmaster General, all the rural mail carriers in your district are required to coöperate with you in reporting forest fires. You should at once get in touch with them, learn their routes, and arrange with them adequate methods for notifying you or the Forest Fire Foreman of your district of the occurrence of fires.

(15) You will be expected to make the following reports to the State Forester:

a. A time report, showing the amount of time each day you have worked, the kind of work done and the number of people interviewed, such as is called for on the form which is being furnished you. It is required that, in addition to this form, you keep a diary, showing, in more detail than is possible on the form, the work done, the places visited, the miles patrolled, the fire fighting done, the names and addresses of people interviewed, and any information about ownership of land in your district which will be of benefit to you in your work. Brief daily weather notes should also be included. From this diary the time report can be made out.

b. As soon as possible after the occurrence of each fire in your district, certainly within ten days, an account of it must be sent to the State Forester on the form which is being supplied you for that purpose. Franked return envelopes will be supplied you for mailing the above reports.

Please notify me at once that you have accepted this appointment.

Very truly yours,

J. S. HOLMES,

Collaborator, U. S. Forest Service and State Forester.

Instructions for Federal Patrolmen:

In addition to the letter of appointment some general instructions are sent out to the Federal patrolmen. The following, adapted from those sent out by the State Forester of Texas, have been sent out with appointments during the spring of 1918.

GENERAL INSTRUCTIONS FOR PATROLMEN

"Conscientious performance of your duty is expected each day and all day work except on Sundays, when you are only expected to do absolutely necessary work. Not less than eight hours will be acceptable as a day's work. You are employed on a monthly basis, and every working day must be properly accounted for. Plan to spend some Saturday afternoons in towns where you can meet large numbers of people from the surrounding country. During heavy rains, when it would be impracticable to ride long distances, endeavor to seek shelter at country stores, sawmills, schools, farms, or

in towns where you can meet people and discuss fire prevention work with them. Cover your district in a studied and systematic manner, aiming to reach as many people as possible.

"Your work is to prevent forest fires. This may best be done by meeting citizens and residents, acquainting them with the importance of preventing fires, and urging them to cooperate with the Government and State to this end. You are expected to explain the causes of fires and the serious damage done by them to all persons who seem ignorant of these matters, and to win their approval and support. There is no place in this fire protective work for ill-will, or lack of harmony, as a result of your dealing with people. You will find your chief usefulness as a patrolman to be in pointing out to people the importance of fire prevention and in convincing them of the soundness of your arguments.

"Become thoroughly familiar with the literature on forest fires which is furnished to you. Make it a point to talk with as many persons as possible. When schools are in session you should seek an opportunity to explain these matters to the children and the teachers.

"You will be supplied with fire literature for distribution and fire notices for posting in conspicuous places, such as postoffices, schools, country stores, lumber camps, commissary stores, sawmills, camping places and cross roads.

"You should secure a notebook in which to take notes during the day for your reports and to record other information of value concerning forest and fire conditions. The reports which you are to submit are intended to show the number of fires by area and causes, the area burned over, and the damage, not only for the fires you see, but also for all the fires which occur in your district. A record for each entire year is desired, and you should make this as complete as possible, both by observation and inquiry. Additional information of direct bearing upon the protective work, such as the distance traveled, number of persons interviewed, amount of literature distributed, number of fire notices posted, and other matters of interest should also be reported."

In addition to these instructions at the time of appointment, the State Forester endeavors to keep in close touch with the Federal patrolmen, both by correspondence and by inspection. Unfortunately, the amount of money available for this purpose is so small that the work has been seriously handicapped by lack of frequent inspection. To make the fire protective system really effective there should be two or three district Forest Wardens in the different parts of the State, whose sole duty would be to organize, direct, and instruct the fire protective work of the State.

FOREST PROTECTIVE ASSOCIATIONS

As soon as the agreement with the United States Department of Agriculture providing for the employment of Federal patrolmen in North Carolina had been signed, steps were taken to secure the necessary cooperation with landowners through the organization of local associations. At a meeting held in Montreat, North Carolina, July 8, 1915, the proceedings of which are reported in Economic Paper No. 42, the Tryon Forestry Club, which had been organized a year or so previously, applied for the appointment of a patrolman to cooperate with them. At this meeting were also landowners of the Mount Mitchell region, and these later organized themselves into the Mount Mitchell Forest Protective Association. A third one, the Linville Forest Protective Association, was organized the following year. All three of these are still in existence and doing much good work.

THE TRYON FORESTRY CLUB

This club, which was organized in 1911, is composed of landowners of Tryon Township and others who are interested in fire prevention, most of whom live in the

village of Tryon. The present officers of the club are officially given as follows: W. T. Lindsey, President; G. H. Holmes, Vice-President; George B. Cobb, Secretary-Treasurer. The amount of land controlled by the members is comparatively small, but their interest and influence is great. Although the amount of money available has been comparatively insignificant, the results of coöperative fire prevention have been most satisfactory.

John Riis was appointed Federal Patrolman for the Tryon district in October, 1915. Among other things, the Federal Patrolman was instructed by the State Forester as follows:

"You are expected to coöperate to the fullest extent with the Tryon Forestry Club. It is understood with them that actual fire fighting is to be done by foremen employed by them under your direction. You are to make all necessary preliminary arrangements with these foremen so that they would know how to proceed without your personal supervision. It may be necessary for you to personally assist them in their fire fighting until they learn the best methods. It is definitely understood that the Tryon Forestry Club is to bear all expenses of fire fighting. Coöperation should also be arranged with the town of Tryon for the protection of its watersheds. You should endeavor to coöperate, as fully as possible, with the employees of the Southern Railway operating within your district."

In the annual report of the Collaborator to the United States Forester for 1915 the following reference to the work in Tryon Township is made:

"The Tryon Forestry Club appointed wardens throughout the township who promised to watch out for and assist in extinguishing forest fires free of cost. The club also did a considerable amount of propaganda work and induced the county commissioners to offer a reward of \$50 for evidence to convict any one setting fire to the woods."

Again, in the Collaborator's report for 1916, the work at Tryon is referred to as follows:

"The coöperation with the Tryon Forestry Club was continued. The Federal patrolman, John Riis, who was appointed in the fall of 1915, continued his work during the spring fire season and made an excellent record. His district comprised the township of Tryon, containing approximately 40,000 acres. Eight fires, burning over a total of 212 acres, occurred in the spring, causing a total reported damage of \$230. Four of these were caused by the railroad, one from smoking, one by a sawmill, one from a burning building, and one unknown. The Tryon Forestry Club has fourteen voluntary fire wardens scattered over the district, who are pledged to fight fires and secure assistance when notified by the Federal patrolman. The people of the township have been interested and active in supporting the work, and the results have been very encouraging. Little financial support, however, has been offered, owing to the small amounts of land owned by members of the Tryon Forestry Club and the apparent impossibility of collecting assessments or greatly extending the membership."

Again, in his report for 1917, the following reference is made:

"The Tryon Forestry Club, although small in numbers and comparatively insignificant as to land owned by the club members, did good work. The originator of several incendiary fires was arrested and prosecuted, resulting in his leaving the State. A special subscription was taken up for fire fighting most of which was expended; and although more fires occurred during the spring than usual, they were kept down to a low average area. The club reorganized and changed its management, which resulted in closer and more effective coöperation. A Federal patrolman covered the district both spring and fall."

Reports of forest fires from the Federal patrolmen in this township for the past three years show the following results:

TABLE 17.—FOREST FIRES IN TRYON DISTRICT SINCE FEDERAL PATROL BEGAN

Date	Area of Fire—Acres	Total Damage	Cost of Extinguishing	Cause of Fire
1916				
Mar. 14.....	5	\$.....	\$ 6.00	Sawmill.
17.....	$\frac{1}{2}$	.....	.50	Railroad locomotive.
19.....	100	.....	20.50	Burning building.
20.....	1	100.00	1.00	Railroad locomotive.
21.....	3	10.00	6.40	Railroad locomotive.
22.....	1	10.00	4.15	Unknown.
23.....	2	10.00	1.90	Railroad locomotive.
30.....	100	100.00	15.00	Unknown.
Nov. 18.....	1-10	None	.40	Smoking.
1917				
April 1.....	25	500.00	10.00	Children.
7.....	2	None	1.40	Railroad locomotive.
12.....	10	14.00	4.25	Unknown.
16.....	7	7.00	4.85	Railroad locomotive.
20.....	33	300.00	15.85	Burning brush.
20.....	1-10	5.00	.30	Railroad locomotive.
20.....	1	6.00	1.20	Railroad locomotive.
May 11.....	$\frac{1}{2}$	12.00	.20	Incendiary.
14.....	1	25.00	1.60	Incendiary.
14.....	1	20.00	10.00	Incendiary.
19.....	25	625.00	7.20	Railroad locomotive.
22.....	1	20.00	.30	Railroad locomotive.
Nov. 7.....	*150	.....	36.35	Entered from South Carolina.
11.....	1	None	.90	Railroad locomotive.
Totals.....	470	1,764.00	150.25	

*This fire burned over many thousand acres in North and South Carolina. One hundred and fifty acres burned in Tryon District. No estimate made of damage, but very serious in this district.

The above statement covers a period of two and one-half years, there having been no fires in the Tryon district during the fall season of 1915. When it is considered that this district five years ago was one of the worst for fires in the State, some idea can be gathered of the value of patrol work. The average fire in this district burned over about 20 acres, whereas the average fire in the mountain region as a whole, covering approximately the same period, was 226 acres. Again, the average area per township reporting annually burned over in the mountain counties during the past three years was 753 acres, whereas the average area annually burned over in the Tryon district was 188 acres. Again, the average damage caused by each fire in the entire mountain region during the past three years has been \$555, whereas the average damage per fire in the Tryon district was \$76.70. In other words, a saving of \$478 per fire has been effected at an average cost of \$6 per fire for extinguishing it, plus \$25 per fire for patrol.

Report on Operations of Tryon Forestry Club for Year 1917:

In February, 1917, a meeting of the club was held, with the object of planning for operations for the current year. The question of dues was brought up and discussed, as dues had not been collected regularly in the past. Various suggestions

were made, but no decision arrived at, and the meeting adjourned after Captain Bernard Sharp had undertaken to collect some funds for fire-fighting purposes. Captain Sharp succeeded in collecting a fund which is shown in the statement herewith submitted.

During April and May a number of fires occurred, which were, in almost every case, extinguished by our fire fighters before they had done much damage. Quite a few fires were started by locomotives on the railway. In these cases the section-hands on the railway helped to extinguish the fire, if they were near enough to be communicated with.

The fall danger season was short, owing to snow early in December. In the early part of November some bad fires occurred, one especially, starting at such a distance from Tryon that it had gotten too large to control before it was visible from this patrol district. By the efforts of our fire fighters it was held back and prevented from doing much damage in our district.

The educational work being done by the State Forestry Department in coöperation with the Tryon Forestry Club is having a very beneficial effect in creating a sentiment among the mountain people against the setting out of fires.

Financial Statement:

No complete financial statement was received from the Tryon Forestry Club until quite recently, and this only includes receipts and expenditures for the year 1917. A summary of this statement is herewith given.

1917.	Disbursements.	Receipts.
Jan. 1. By amount on hand		\$ 10.84
Nov. 26. By town of Tryon, cost of protecting town watersheds..		27.25
Dec. 31. By voluntary subscriptions		110.00
May 31. To labor and expenses, fire fighting	\$ 20.82	
To employment of patrolman, 5 days	7.00	
June 12. To back pay of patrolmen, additional time, 1916.....	25.00	
Nov. 30. To labor and expenses, fire fighting	27.25	
Dec. 31. To tools and livery expenses	2.80	
Balance on hand	65.22	
Total	\$148.09	\$148.09

No funds were collected as regular dues.

MOUNT MITCHELL FOREST PROTECTIVE ASSOCIATION

With the assistance of Mr. L. L. Bishop, then supervisor of the Mount Mitchell National Forest, an association of a number of the large and smaller landowners of the Mount Mitchell region was formed in the fall of 1915. The proposed working outline of this association, as given in Economic Paper No. 42, pages 27 to 31, was followed as closely as possible in its organization, but this was subsequently considerably modified. At the present time a number of the landowners included in the preliminary arrangements are now doing their own fire protection without paying dues to the association. The work, therefore, is rather loosely organized, although the association, still supported by several influential members, is doing good work. At the present time the board of directors is constituted as follows: F. A. Perley,

Black Mountain, president; A. R. Bauman, Montreat, secretary and manager; J. P. Parker, Black Mountain, C. P. Kerlee, Black Mountain, and J. G. Stikeleather, Asheville.

The annual fire report of the Collaborator to the United States Forester for 1915 states:

"In the Mount Mitchell region several large landowners got together and formed the Mount Mitchell Forest Fire Protective Association. In all, \$385.95 was contributed to the funds of this association, up to December 31. Disbursements for fire protection purposes amounted to \$253.57, which leaves a balance of \$132.38 to start the work in the spring.

"In addition to the two patrolmen and the two foremen paid from the fund, two patrolmen paid by the Asheville City Waterworks coöperated with the association; and the employees of the Perley & Crockett Lumber Company, which operates within the protected area, assisted in fighting fires.

"Two Federal patrolmen, appointed by the State Forester under the Weeks Law, coöperated with this association; one man's district being in Buncombe County, the second one's in Yancey County."

Reference to this Association in the report for 1916 is as follows:

"The Mount Mitchell Forest Protective Association, which was organized in the fall of 1915, continued a somewhat precarious and disjointed existence. Several of the landowners who originally appeared much interested failed to pay any assessment, and little constructive work was done. A total of \$240 was collected on assessments, and this, together with a balance on hand from the previous year, amounting to \$132.38, gave a total working balance of \$378.38. In spite of the very serious spring fire season, only \$30 to \$40 was spent, so that at present there is a balance on hand of some \$340. Perley & Crockett, the largest contributors, have, besides the cash assessment, furnished some protection from their men operating along some thirty or more miles of logging railroad. Two Federal patrolmen coöperated with this association during the spring fire season. One, working along the railroad, reported some 84 fires during March, April, and May, none of which got beyond control. The other patrolmen reported 5 fires, covering 357 acres, and a total damage of \$620. Partly owing to a misunderstanding as to what district the Federal patrolmen should be appointed for, no such patrolmen were appointed for the fall fire season."

The substance of the reference to the work of this association in the Collaborator's report for 1917 is as follows:

"The Mount Mitchell Forest Protective Association has done some good work, although greater interest on the part of the management would have resulted in increased benefits. No dues were paid by members, partly because requests for them were not sent out until late in the season. Fortunately, some \$300 was left over from the previous year, and part of this was used for fire-fighting expenses. No regular patrolmen were employed by the association, although railroad patrolmen employed by the Perley & Crockett Lumber Company were paid partly from association funds. One Federal patrolman coöperated in the Black Mountain region, both spring and fall, and an additional one patrolled in the neighborhood of Mount Mitchell during the fall fire season."

Financial Statement:

The following financial statement of the association since its organization shows that private landowners in the mountains are willing to pay out money for fire prevention.

CONDENSED STATEMENT OF RECEIPTS AND DISBURSEMENTS OF THE MOUNT MITCHELL FOREST PROTECTIVE ASSOCIATION FOR 1915-1917, INCLUSIVE:

	1915	Disbursements	Receipts
Contributions from members			\$ 385.95
For tools and tool boxes		\$ 94.78	
Salaries of patrolmen and foremen		158.79	
Balance		132.38	
Total		\$ 385.95	\$ 385.95
1916			
Balance on hand January 1			\$ 132.38
Contributions from members.....			240.00
For fire fighting		\$ 31.08	
For expenses of Secretary		17.49	
Balance on hand December 1		323.81	
Total		\$ 372.38	\$ 372.38
1917			
Balance on hand January 1			\$ 323.81
Contributions from members.....			11.00
For fire fighting		\$140.15	
For expenses of Secretary		2.51	
Balance on hand December 1		192.15	
Total		\$ 334.81	\$ 334.81

LINVILLE FOREST PROTECTIVE ASSOCIATION

The Linville Forest Protective Association was organized at a call meeting held at Linville, N. C., February 25, 1916. This meeting was attended by a number of representative landowners of the region, who showed their interest in the movement by coming out on one of the coldest and most stormy days in the year. The tentative articles of association given below were adopted and the following board of directors elected: F. P. Howe, Johnson City, Tennessee, president; W. S. Whiting, Elizabethton, Tennessee, vice-president; J. P. Gibbs, Linville, N. C., secretary-treasurer; L. D. Ellis, Cranberry, N. C., and E. G. Underdown, Blowing Rock, N. C.

List of Members:

The following landowners and railroad companies subsequently signified their approval of the step by applying for membership and paying their dues:

Name	Postoffice Address	Acreage	R. R. Mileage
Boone Fork Lumber Company.....	Elizabethton, Tenn.	4,286	4
Brown, P. Maclay.....	Crosnore, N. C.	800	
Cone, Mrs. Moses H.	Blowing Rock, N. C.	3,700	
Cranberry Iron and Coal Company.....	Johnson City, Tenn.	3,700	
Daingerfield, Elliott	Blowing Rock, N. C.	27	
East Tenn. and Western N. C. Railway....	Johnson City, Tenn.		2½
Galloway-Pease Lumber Company.....	Saginaw, Michigan	1,200	
Guy, E. C.	Newland, N. C.	563	
Hartley, J. L.	Linville, N. C.	200	
Highland Nursery Company.....	Pineola, N. C.	100	
Hughes, Edward W.	Blowing Rock, N. C.		
Linville Improvement Company.....	Wilmington, N. C.	16,000	
Linville River Railroad Company.....	Johnson City, Tenn.		26
MacRae, Hugh	Wilmington, N. C.	195	
Sanford & Treadway	Elizabethton, Tenn.	1,300	
Webb, N. P.	Pineola, N. C.	190	

The first annual meeting of this association was held at Linville, October 3, 1916. Following the resignation of Mr. Howe as president, Mr. P. MacLay Brown of Crossnore was elected to this position. Mr. A. W. Wasey, manager of the Boone Fork Lumber Company, Shulls Mills, was elected vice-president in the place of Mr. Whiting, who had resigned. The other members of the board of directors were reelected. The articles of association, comprising the constitution and by-laws, which were prepared and submitted to the president the previous spring, were carefully discussed, revised, and adopted. They were later sent out to all members of the association as having been adopted by the association at large. As these may hereafter form a basis upon which to organize similar associations in other parts of the State, they are here given in full.

ARTICLES OF ASSOCIATION, CONSTITUTION AND BY-LAWS

ARTICLE I

Name: The name of this Association shall be *The Linville Forest Protective Association*.

Object: And its object the preservation of the forests of Avery, Caldwell, Watauga, and adjoining counties in North Carolina from loss or damage by fire.

ARTICLE II

Place of Business

Headquarters: The principal place of business of this association shall be Linville, Avery County, North Carolina.

ARTICLE III

Government

Control: The affairs of this association shall be controlled by a board of directors, and five members shall constitute a full board.

ARTICLE IV

Membership

SECTION 1. Any person, firm or corporation, who either as owner, agent, lessee, or in any other capacity is interested in the ownership or management of forest lands within the limits specified in Article I shall be eligible to membership in this association. Those executing this instrument on or before.....191.., shall be considered charter members.

SEC. 2. Any person, firm, or corporation, in addition to those executing this instrument, or any acting as agent for such person, firm, or corporation, desiring to become a member of this association, shall apply to the secretary in writing, which writing shall state the location and approximate forest acreage of such land and miles of railroad or tramroad operated or under construction by him.

SEC. 3. Applications for membership must be passed upon and the proposed members elected or rejected by the board of directors at their next meeting after receipt thereof, and it shall take a majority affirmative vote to elect to membership.

SEC. 4. No person, firm, or corporation shall exercise the rights or be entitled to the privileges of membership until he, or it, shall have signed the roll and subscribed to these Articles of Association and By-Laws.

SEC. 5. The interest of each member shall be equal to that of any other member, and no member can acquire an interest which will entitle him to a greater voice, authority, or interest than any other member.

SEC. 6. Membership in the association may be terminated by formal withdrawal of the member, which shall be in writing, delivered to the secretary, by death or expulsion, provided that termination of membership shall not relieve the member of the liabilities of the association then existing.

SEC. 7. A member may be expelled from the association for any of the following reasons:

- a. Failure to timely pay any assessment levied by the association.
- b. Failure by a member to observe and conform to the by-laws of this association.
- c. The board of directors shall have the power to expel members, but it shall take a majority vote of all directors to expel, and then only after due hearings and for cause.

SEC. 8. When an individual, firm, or corporation ceases to be a member of the association for any cause, he shall receive no remuneration for any interest he may claim in the property of the association. Membership in the association gives no interest in the property of the association, or in the land or timber holdings of any other member of the association.

SEC. 9. Any person interested in forest protection in western North Carolina, even though owning no acres of woodland within the limits specified, nor being pecuniarily interested in any woodland, may become an honorary member of this association upon the majority vote of all members present at any regular meeting.

SEC. 10. Dues for honorary membership shall be one dollar (\$1) per annum, but donations in excess of this amount may be contributed.

SEC. 11. Honorary members may take part in all meetings, discussions, and other activities of the association, but their vote may be suspended on questions of policy and finance.

ARTICLE V

Assessment

SECTION 1. The funds to defray the expenses of the association shall be raised by assessment of the members thereof, as shown by the roll of membership.

SEC. 2. The board of directors shall have the power to levy and enforce the payment of assessments to defray the expenses and maintenance, and to promote the objects of the association.

SEC. 3. The amount of assessments shall be determined by the board of directors, and shall be made uniform, based on the total acreage of lands of the members and upon the total mileage of railroad lines either operating or under construction, owned or operated by members. In no case shall an assessment exceed the sum of one-half of one cent per acre and \$5 per mile of railroad, nor shall more than two such assessments be made during one calendar year; provided: That in cases of emergency seventy-five per cent of the membership may vote an additional necessary assessment. Each member shall be required to pay assessments on the basis of the numbers of acres and miles of railroad each controls, owns or is interested in. Members who own no land or lines of railroad shall not be required to pay an assessment of more than \$1 per year, though contributions exceeding that amount may be accepted.

SEC. 4. When assessment shall have been levied by the board of directors, notice thereof shall immediately be sent to the members of the association, and all such assessments must be paid within thirty days from notice thereof, and no additional assessments shall be called until at least thirty days after the previous assessment.

ARTICLE VI

Meetings

SECTION 1. There shall be an annual meeting of the association, held at its principal place of business on the second Tuesday of August of each year, for the election of directors to manage the affairs of the association for the ensuing year and for the transaction of such other business as may properly come before it.

SEC. 2. Notice of the time and place of the annual meeting shall be sent at least ten days prior thereto by the secretary to each member to the address appearing on the records of the association as the postoffice address of such member, and such notice shall be sufficient.

SEC. 3. Special meetings of the association may be called at any time by resolution of the board of directors, by the president, or by the secretary upon request of not less than four regular members. Seven members shall constitute a quorum for the transaction of business.

SEC. 4. The order of business at all meetings of the association and of the board of directors shall be, as far as practicable, as follows:

- a. Call to order
- b. Calling of roll
- c. Reading of minutes of previous meeting
- d. Approval of minutes of previous meeting
- e. Report of secretary-treasurer
- f. Report of manager
- g. Reports of committees
- h. Election of members
- i. Election of directors and officers
- j. Unfinished business
- k. Communications
- l. New business
- m. Adjournment.

SEC. 5. The board of directors shall hold meetings on the second Tuesday of August of each year at the principal place of business of the association, and such other meetings as they may deem proper and wise. The president or a majority of the directors may at any time call a meeting of the board of directors.

ARTICLE VII

Board of Directors

SECTION 1. The board of directors shall have power to fix the time and place of all regular (and special) meetings, to appoint committees, either from their own members or members from the association or their representatives, or in such cases as in their discretion seem advisable, to authorize the president to do so.

SEC. 2. They shall have power to adopt and carry into effect such measures as they deem proper to promote the object of the association.

SEC. 3. They shall have power to levy all assessments, based upon the acreage and railroad mileage of each member, compared with the whole acreage and mileage of the entire membership.

SEC. 4. They shall have power to appoint and to fix the salaries of any and all agents or employees of the association, except such as are fixed by law; to authorize the payment of all obligations incurred by the association; and to transact all other business of said association.

SEC. 5. A majority of the members of the board of directors shall constitute a quorum for the transaction of general business, and the president shall be chairman of the board of directors.

SEC. 6. The directors may elect members of the association to fill vacancies on the board caused by death, resignation, or other causes.

SEC. 7. The directors shall have power to do all other business and transact all other business that may lawfully be done and transacted under the laws of North Carolina.

ARTICLE VIII

Officers

SECTION 1. The officers of the association shall consist of a president, a vice-president, a secretary-treasurer, and a board of five directors, who shall be elected at the annual meeting of the association, and who, in all cases, shall be members of the association.

SEC. 2. The president shall preside at all meetings and shall have general supervision of the affairs of the association.

SEC. 3. The vice-president shall exercise all the functions of the president in the absence of the president.

SEC. 4. The secretary-treasurer shall issue notices of all meetings of the association, either regular or special meetings of the board of directors; he shall sign with the president such instruments as require his signature and shall keep and issue lists of the members of the association; he shall collect assessments levied by the board of

directors, make out vouchers covering legitimate expenses of the association and attest them, shall make out reports, and shall perform such other duties as are incident to his office or are properly required of him by the board of directors. He shall receive all moneys belonging to the association, keep an accurate account of same and pay them out only upon a duly authorized voucher drawn by the secretary with the approval of the board of directors. At the end of his term of office he shall turn over to his duly elected successor all moneys in his hands belonging to the association.

ARTICLE IX

Term of Office

The term of office of all officers of the association shall be one year from the second Tuesday in August of each year, or until their successors are duly elected and have qualified.

ARTICLE X

Amendments

These articles may be amended at any annual meeting, or special meeting, of the members of the association by a majority vote of the members present, in person or by proxy, at such meeting; said amendment must, however, be submitted to the secretary in writing at least one month before said meeting, or in ample time for him to incorporate same in his notice or call for said meeting, which notice shall in all cases contain the full text of the proposed amendment.

The second annual meeting was unavoidably delayed and was not held until October 9, 1917. Delegates to this meeting came from Wilmington, Asheville, and other points. Great interest was shown in the work. An important change was made by electing a secretary separate from and in addition to the manager. The following board of directors was elected for the ensuing year, two of the officers having had to resign on account of the exigencies of war: E. C. Robbins, Pineola, N. C., president; T. W. Hampton, Shulls Mills, N. C., vice-president; J. P. Gibbs, Linville, N. C., manager; L. D. Ellis, Cranberry, N. C., and E. G. Underdown, Blowing Rock, N. C. George C. Love of Pineola, N. C., was elected secretary.

The work of this association was referred to in the Collaborator's report to the United States Forester for 1916 as follows:

"In spite of the very limited assistance the State was able to contribute, owing to the lack of an appropriation, private coöperation was extended in 1916. The Linville Forest Protective Association was definitely organized in February, with headquarters at Linville in Avery County. Landowners, extending from Blowing Rock on the Blue Ridge westerly almost to the Tennessee line and controlling an area of some 33,000 acres in Avery, Caldwell, and Watauga counties, agreed to some general articles of association, a copy of which is attached. The chief feature of these articles is the assessment, which is based not only upon the amount of land represented, but also upon the miles of railroad operated or under construction in the area. A preliminary assessment of half a cent an acre and \$5 per mile for railroads was paid in by all members. A total of \$330.68 was thus contributed to the fire protection fund of this organization. Owing possibly to a failure on the part of the management to grasp the necessity for vigorous action, few patrolmen were appointed and comparatively little of this sum was spent. Unfortunately, a considerable number of serious fires occurred both on and surrounding this area, which might at least in part have been prevented had more complete control been organized. Though a second assessment of the same size was expected before the fall fire season, it was not thought necessary to call for this, so that only the first assessment has been made. One Federal patrolman coöperated with this association, with his district at the extreme eastern end of the area. A second patrolman was offered to the association during the fall fire season, but the season was so short and light that this was not taken advantage of."

The report of the Collaborator for 1917 contains this reference:

"The Linville Forest Protective Association, controlling some 33,000 acres in Avery, Caldwell, and Watauga counties, employed two patrolmen throughout the spring and fall fire seasons. In addition to these two men, some of the members employed their own patrolmen, who cooperated with those employed by the association. The members are thoroughly interested, and practically all of them have paid their dues to date; \$316.91 semiannual dues having been received during the fall. No account, however, has been received of expenditures. One Federal patrolman cooperated with this association, both in the spring and fall, on the Blowing Rock end of the district.

"No complete official statement has been submitted by the manager, so that only an incomplete one can be supplied. As all the subscriptions of this association have been made through the office of the State Geological and Economic Survey, the receipts, therefore, are known. A statement of expenditures has recently been submitted by the manager.

Financial Statement:

LINVILLE FOREST PROTECTIVE ASSOCIATION

	1916	Disbursements.	Receipts.
Semi-annual dues from members.....			\$ 330.68
Salaries of patrolmen, fall season	\$ 85.40		
Balance on hand December 31	245.28		
Total	\$ 330.68		\$ 330.68

	1917		
Balance on hand January 1		\$ 245.28	
Semi-annual dues from members.....			315.91
Fire-fighting tools	\$ 82.59		
Salaries of patrolmen, spring season	178.40		
Fire fighting, spring season	27.00		
Salaries of patrolmen, fall season	76.00		
Postage	2.00		
Balance on hand December 31, 1917	195.20		
Total	\$ 561.19		\$ 561.19

PROPOSED SMOKY MOUNTAINS PROTECTIVE ASSOCIATION

Several efforts have been made to enlist the interest of the large timberland owners of the Smoky Mountains region of the State in organized fire prevention, but so far no substantial results have been effected. A plan outlined and submitted to these owners by mail was later advocated by the State Forester before many of them at the spring meeting of the Appalachian Logging Congress held in Asheville, N. C., April 28-29, 1916. This plan differed from those of associations already established chiefly in the proposal to maintain several lookout stations on the higher peaks of the district.

The plan as presented at this meeting was as follows:

Object: The object of this association should be to protect from fires the lands of the members by the employment of patrolmen, lookouts, etc., and by cooperation with the State and Federal governments.

Area: The area covered by this association would be bounded, roughly speaking, by the Tennessee State line on the north; Pigeon River on the east; the Murphy Branch of the Southern Railway on the south; and the Tennessee line and Hanging Dog Creek on the west. It would thus comprise approximately the northeastern part of Cherokee, the whole of Graham, the northern part of Swain, the northern portion of Jackson, and the northwestern part of Haywood counties.

Organization: The association should be regularly organized, all landowners and operators in the area being eligible for membership. The management of affairs should be in the hands of an executive committee and business transacted as in other organizations.

Management: The entire protective work should be under the management of one man, who should be employed by the association for this purpose. This man should have the energy, training and experience that would fit him for such work. He should be paid for part or all of his time according to the size of the association and the funds available.

If any work ever required the close and undistracted attention of an expert, this does. The chief difficulty in starting small coöperative associations is in securing competent management for the limited compensation they are able to pay. It has been suggested that a good man could look after two contiguous associations; for instance, this and the Pisgah Association, should one be organized, or even this and the Mount Mitchell Association. This seems an excellent plan, and there is no apparent reason why it could not be worked out satisfactorily.

Lookouts: The protective work of the association should be based upon a system of lookouts. These should be near enough together to be seen one from the other, and should be so placed as to command a view of the largest amount of territory. The final decision as to their locations should be left to the manager. All lookouts should be connected with the manager's office by telephone. The following lookouts are suggested:

(1) **TEYAHALI BALD:** This peak commands a view of the greater part of Graham County. It is within a mile or a mile and a half of the telephone from Andrews to Robbinsville. Two additional lookouts in Graham County would make protection much more effective.

(2) **SHUCK STACK:** This commands a view of the extreme western corner of Swain County and most of the northern part of Graham County. It is within a mile and a half of the Montvale Lumber Company's camp.

(3) **HIGH ROCKS:** From this station can be seen all of Hazel Creek and Forney Creek watersheds. It is within a short distance of the Norwood Lumber Company's camp and of the Ritter Lumber Company's operations.

(4) **NEWTON BALD:** This peak commands a view of Deep Creek, Mingus Mill Creek, and the Oconalufy region. It is somewhat farther from telephone communication than the former lookouts, but to make it effective telephones should be built there.

(5) **LUFFY KNOB:** From this Knob can be seen practically all of the Champion Lumber Company's tract, and also the headwaters of Oconalufy.

(6) **PLOTT BALSAM:** In case the landowners in and around the Plott Balsam come into this arrangement, a lookout should be established on one of the highest and best placed of the peaks in this range. Telephone communication should be established with Balsam or some other station on the Southern Railway.

Association Patrol: In addition to the lookouts, and to coöperate with them, it will probably be necessary for the association to employ patrolmen. The number of these and the location of their beats must be determined by the manager upon the ground.

District Wardens: In order to complete the effectiveness of the lookout system there must be men appointed for the different districts who can be depended upon to summon assistance and extinguish fires when notified of them by the lookouts or patrolmen. These men should have access to the tools owned by the association or the tools of some lumber company; they should be paid a retaining fee of \$5 a year for looking out for fires, posting notices, and making reports; they should also be paid for the services they actually render, at a price to be agreed upon between the wardens and the manager; they must know how to fight fire and to handle men.

Tools: In addition to the tools which are, or should be, always available for fire fighting on lumbering operations, the association should own a number of sets of fire-fighting tools, which should be kept at effective points where district wardens or other fire fighters could have access to them. The best all-round tool for fire fighting in these mountains is a strong, short-tined potato fork, which can be used either as a rake or a mattock. Where there is no safe place to put the tools, an association tool box should be made and keys provided for those who use the tools.

Estimate of Costs: The total area covered by the proposed association is approximately 665,000 acres; the acreage necessary to make an effective system, to include all the owners so far approached on the matter, is 375,000; this latter figure has been made the basis of the following general estimate:

Salary of manager, 1 year	\$ 1,200
Expenses of manager, 1 year	500
Five lookouts, 4 months @ \$40 a month.....	800
Telephone construction and tolls	400
Tool boxes	250
Fire fighting	500
District wardens, 20 @ \$5.....	100
	<hr/>
	\$ 3,750

The Federal Government will probably employ two patrols or lookouts five months at \$50 = \$500.

I see no reason why the Southern Railway should not assist by clearing their right of way from Hazelwood to Fontana, a distance of 62 miles, and by instructing their employees to cooperate closely with the association, as they are already doing near Tryon and Black Mountain.

Conditions: It is proposed to assess all members at the flat rate of one cent per acre per year for their total holdings within the area. Where the operator does not own the land, a mutual agreement might be made between the landowner and the operator to pay half of the assessment each. At the same time operators should guarantee to prevent fires as far as possible, and to extinguish at their own expense all fires originating on their own operations.

It is urged that operators either employ patrolmen to carefully police their own lines of railroad and their logging operations during dry and dangerous weather or else consent to an assessment, in addition to the acreage one, of \$10 per mile for all railroads operating or under construction, as is done by the Linville Association. Only in some such way can the risks of operating landowners be equalized.

This question of costs is of course a crucial one. If a landowner feels that he is now getting adequate protection for himself at a cost of one-half cent per acre, a scheme based upon one cent per acre would hardly appeal to him. Yet one can scarcely imagine how any operator in this State can feel secure from fire, or can afford to turn down any proposal, even though costing double what he has been paying, without very carefully looking into the plans.

The basis of one cent per acre is of necessity more or less experimental, because cost figures for protection in this State are not available, but it is based on the experience of similar associations in other parts of this country. (See Economic Paper, No. 42, pp. 10-14.)

Advantages:

1. The proposed plan is not offered because it is cheaper than the present plan of each owner carrying out his own scheme of fire protection, but because it is more effective. The object is to prevent, rather than to extinguish fires.

2. Nearly every man who has tried to protect his own land from fire finds that the fires most dreaded are those originating off his land, which have gathered strength and breadth by the time they reach his boundary. Coöperative protection eliminates most of these fires.

3. The Federal Government prefers to coöperate with an association, rather than with an individual owner; therefore, Federal patrolmen can more readily be appointed where such associations are in existence.

4. Prosecutions can be brought in the name of the association without endangering personal enmity.

5. The State Geological and Economic Survey can appoint a certain number of the responsible wardens, patrolmen, and lookouts employed by the association as State Forest Wardens, giving them authority to arrest without warrant, to summon help to fight fires, and furnish them with a badge of office according to law.

When a State appropriation can be secured to carry out the provisions of the new Forestry Law, wardens paid by the State can be appointed to cooperate with this and other associations.

A Private Lookout Station Established:

In line with the above fire protective scheme, one of the largest owners and operators of the Smoky Mountains region has now established a lookout for the benefit of its own property. On April 23, 1917, Mr. George L. Wood, general manager of the Montvale Lumber Company, wrote the State Forester in part as follows:

"We have now completed the installation of telephone service to Little Shuck Stack Mountain, which point is located about one-half mile due east of Shuck Stack Mountain, and while this Little Shuck Stack Mountain may not show on your map, there are some maps on which it is shown, and it carries about the same relative height as does Shuck Stack Mountain, and Little Shuck Stack affords a most excellent view of our entire Eagle Creek holdings, together with much of the surrounding country.

"We enclose herewith copy of instructions that we sent to our Superintendent at Fontana to be followed in maintaining the service of a lookout.

"Most of our forest fire trouble on Eagle Creek has been due to fire approaching our property from the Twenty-mile side, and this is one of our strong reasons for selecting Little Shuck Stack as a lookout, so we can keep a general lookout over the west as well as discover any that originate on our Eagle Creek holdings. Just how far the adjoining timber holders will cooperate with us we do not know, but will try and write you further."

Letter of Instructions for Guidance of Lookout:

BALTIMORE, MD., April 18, 1917.

W. W. PRUETT, *Superintendent,*

Fontana, N. C.

The following instructions shall be closely followed and rigidly enforced governing the operating and maintaining of the lookout station which has been established on Little Shuck Stack Mountain, which point is within the property lines of the Montvale Lumber Company, and which point has been selected for a lookout station because it affords an excellent and unobstructed view of the entire watershed of Eagle Creek and much of the surrounding country, from which point also can be plainly seen lands owned by many other timberland owners within a radius of many miles.

Duties of Lookout:

a. The lookout shall arrive at the lookout station not later than 8 o'clock each and every morning and remain on constant duty until near sundown during dry weather during the spring and fall periods. (During damp and wet days the lookout shall not be required to report at the lookout station for duty.)

b. Immediately upon arrival at the station he shall make a thorough view inspection of the entire watershed of Eagle Creek to detect and definitely locate any forest fire that may then be burning on the property of the Montvale Lumber Company.

c. Immediately following the view inspection of Eagle Creek he shall then carefully look over the surrounding territory in every direction and definitely locate as nearly as possible any forest fire that may then be burning.

d. Promptly upon completing the above observation under b and c, he shall call by phone the general officer of the Montvale Lumber Company, at Fontana, N. C., and report the results of his observation clearly and distinctly, and if any fire or fires have been noticed, to give location and size as correctly as possible, at which time the Fontana office will promptly detail sufficient men to extinguish it, if on the property of the Montvale Lumber Company.

e. He shall remain constantly on duty throughout all dry days and report all forest fires to the Fontana office just as quickly as possible after location and size of fires have been determined.

f. In addition to reporting fires as they appear, he shall also call and report to the office by phone each hour, on the hour, stating whether any fires can be sighted and if everything is O. K.

g. He shall be supplied with and keep a record book in the phone station box in which he will record daily (when on duty) the hour of his arrival, the location, size and time of all forest fires sighted and reported by him, and a report of weather conditions, direction of the wind and its estimated velocity, and the exact time of his departure from the lookout station for the night.

PROPOSED EASTERN CAROLINA FOREST PROTECTIVE ASSOCIATION

Following the disastrous forest fires of 1916 in which millions of dollars worth of property was lost by the timberland owners of this State, the members of the North Carolina Pine Association, with headquarters at Norfolk, Va., became aroused to the necessity of doing something definite to protect their timberlands from fire. The subject was presented by the State Forester and by two or three Federal foresters at two successive monthly meetings of the association in the spring of 1917, and conferences were held by interested members to decide on the preliminary steps. The following outline which might form the basis of organization was submitted to a number of the more or less interested members of the association. Owing partly to the entrance of the United States into war and the consequent interruption of business, no further action has yet been taken. It is hoped that Eastern North Carolina may soon have one or more strong associations of this kind to assist the State and Federal governments in protecting the valuable forests from fire.

Suggestions for the Management of the Proposed Forest Protective Association in the Coastal Plain Region of North Carolina, Virginia, and South Carolina:

1. That the proposed association be independent of the North Carolina Pine Association, and be formed under the laws of North Carolina, as practically all the land represented by the possible members would be in North Carolina. The name "Eastern Carolina Forest Protective Association" has been suggested.

2. On the basis of one million acres, a minimum annual revenue of \$10,000 would be received. Approximately \$2,500 of this should be spent for the salary and field expenses of the manager, who should be a man of experience, tact, and enthusiasm, employed on a good salary, and spending the larger part of his time in the field. His correspondence might be handled largely through a clerk who might, a part of the time, be otherwise employed by some member of the association.

3. The funds should be handled by a treasurer, who should be a well-known public man, so that all members and employees would have confidence in him. The clerk or the manager might, with advantage, be in the office of the treasurer.

4. The sum of \$1,000 should be reserved for contingencies.

5. The remaining \$6,500 should be spent almost entirely for the employment of forest wardens, who should be paid for patrolling, educational work, fire fighting, etc., at the average of one hundred days a year, or approximately \$250 each. This would provide for 25 wardens to look after one million acres of forest land, giving each one an average of 40,000 acres.

6. These forest wardens should go on duty ten days or two weeks before the dangerous fire season commences each spring and fall. This part of their time should be devoted to posting notices and to other publicity and educational work.

7. Fire-fighting expenses should be paid as soon as possible by the association, but these costs should be assessed by the association on the land benefitted, or on the parties responsible for the fire.

8. Local or district wardens who are employed for fire fighting only should not be paid, except for fire fighting, unless it were thought advisable to pay them a retain-

ing fee of \$5 or \$10 each. These men would be at the call of the regular forest wardens, and should take charge of fire fighting and summon assistance in the absence of the forest wardens.

9. Forest wardens in North Carolina might be appointed State township wardens under the State Forestry law, provided acceptable men were employed. This would give them the backing of the State law and make their work effective.

10. All forest wardens and other employees of the association would be requested to fill out reports in regard to forest fires, etc., for the State Forester from time to time, as might be requested by him.

J. S. HOLMES,
State Forester.

CO-OPERATION WITH RAILROADS

In Economic Paper No. 33, pages 48 to 52, published in 1913, reference is made to coöperation in fire protection furnished by railroads in other states.

So far no very extensive coöperative arrangements have been entered into between the railroads operating in North Carolina and the State Forester, and none can be expected until the State takes a more active and broadminded grasp of the situation. Several of the large railroads of the State have, however, taken decided steps to control fires along their own roads, and some of them have coöperated either directly with the Survey or through the Forest Protective Associations.

SOUTHERN RAILWAY

In response to a request by the State Forester for assistance in controlling fires along the line of the Southern Railway in Polk County where it penetrates the Tryon Forest Fire District, the following instructions were issued to train crews and track forces:

BULLETIN

ASHEVILLE, N. C., October 22, 1915.

ENGINEERS AND CONDUCTORS:

I have just been advised that the Tryon (N. C.) Forestry Club has secured the appointment of a Federal patrolman for that community, which includes territory on both sides of our main track between Tuxedo and Landrum, and the patrolman, whose name is John Riis, will have headquarters at Tryon, North Carolina.

I have been requested by the State Forester of North Carolina to coöperate with the patrolman in the way of reporting fires, either on or off of our right of way, in the territory above mentioned, and to the end that we may be of some assistance in the matter of preserving the forests. I am going to request that you report by telegraph to our agent at Tryon, N. C., in each instance when fire is discovered by you in territory referred to, and the agent at Tryon, who will receive a copy of this bulletin, will arrange to extend notice to patrolman with as little delay as possible, using his station-hand to deliver such notice, provided there be no other means of reaching the patrolman.

Please be governed accordingly.

F. S. COLLINS,
Superintendent.

Post:

Asheville—Old Yard office
Asheville—New yard office
Asheville—Roundhouse
Hendersonville
Saluda
Hayne
Biltmore.

Cy Agent Tryon, N. C.

Cy W. G. L.

The above is self-explanatory, and you will please arrange at once to instruct all of your track foremen in the territory referred to, that in addition to their lending assistance in extinguishing fires either on or off the right of way, that they will also promptly notify the patrolman through our agent at Tryon in each case of fire; it being understood that such foremen as do not work in and out of Tryon can get to some other telegraph office when telegraphic report is made.

Cy A. S. G. as information.

BULLETIN

ASHEVILLE, N. C., March 13, 1916.

ENGINEERS AND CONDUCTORS:

Please refer to my bulletin of October 22, regarding appointment of Federal patrolman, to look after territory between Tuxedo and Landrum, with headquarters at Tryon, North Carolina.

I have just been advised by State Forester Holmes that he has reappointed Mr. John Riis as Federal patrolman throughout the spring fire season, and requests that we cooperate with him in the way of reporting fires, either on or off the right of way in the territory mentioned, and in each instance when fire is discovered by you, you will promptly make a wire report to our agent at Tryon, N. C., who will convey the information to Mr. Riis.

Please be governed accordingly.

F. S. COLLINS,
Superintendent.

Post at:

Asheville—"XO"
Asheville—Roundhouse
Biltmore
Hendersonville
Saluda
Hayne.

Cy Agent Tryon, N. C.

Cy Roadmaster, Asheville.

Please see mine of October 22, and renew your instructions to track forces in regard to the matter.

This railway has, for several years, been cooperating with the National Forest Administration by cleaning up its right of way through the Mount Mitchell National Forest.

In addition to this, the section crew at Black Mountain has cooperated with the Federal patrolman there in clearing the railroad right of way each year of inflammable material.

OTHER RAILROADS

The East Tennessee and Western North Carolina Railroad, which only penetrates this State for a few miles in Avery County, and the *Linville River Railway*, which runs from Cranberry in that county to Shulls Mills, are both cooperating heartily with the Linville Forest Protective Association, in which they are charter members. Besides paying their semi-annual dues at the rate of \$5 per mile of track, they have employed patrolmen specially to watch out for fires. The latter railway has one or more men on speeders to follow trains along that part of their line where the risk is greatest during dry and dangerous weather. They have also assisted in cleaning up their right of way by cutting out and burning brush and cleaning up leaves. These measures are not entirely optional with the railroad, however, as long stretches of their right of way were granted free of charge, on condition that extraordinary precautions were taken and maintained to prevent fires. It is, in this case, as it should be in all cases, the main purpose of both land-owner and railroad to cooperate in the prevention of fires.

The Carolina, Clinchfield and Ohio Railway, which lost so heavily by the fires of 1916, although it does not attempt to coöperate with the State in fire prevention, has been cleaning up part of its right of way in North Carolina with the object of reducing the claims for fire damage. The general manager of this road, Mr. L. H. Phetteplace, writes on April 27, 1918:

"We have cleaned the right of way varying in width from 100 to 200 feet from the South Carolina line to Linville Falls, North Carolina, a distance of about sixty miles, with the result that we have had only three small fires this spring in this distance of sixty miles, the claims for which will not amount to more than \$150. We expect to continue this work of cleaning our right of way, doing the work in such a manner that we will in the future be able to mow this right of way each year. In general, the instructions to roadmasters or section men are these: Our engineers or any of our trainmen noticing fires along the track are required to throw off to the first section men notice of such fires, and instructions in force to section men require that they go immediately to the scene of the fire and endeavor to put it out. They are also authorized to call upon any one that they may be able to secure to assist them."

Mr. J. D. Stack, general superintendent of the *Norfolk Southern Railway Company*, in an interview published in the *Raleigh News and Observer* for April 22, 1916, says, in part:

"The Norfolk Southern is ready to coöperate heartily in the work of putting out forest fires. I have on several occasions stopped trains on which I was riding and had the crew go to work to extinguish fires when I saw that there was any chance to succeed. Other representatives of the road have similar instructions. We feel that what is good for the country through which our lines run is good for the railroad, and then, of course, we are doing what we can to save our own property."

"What is needed is the willingness of the people living in the sections subject to these fires to turn in when a fire has started and is still in its incipency and put it out. Our people must not lose interest the moment they see their own property is safe; they must think of the other fellow and the common good. . . .

"The Norfolk Southern has increased its pay rolls several thousand dollars the past year in making inspections of the netting of engines to guard against fires. We have records on file showing how thorough and extensive this inspection has been, these records indicating by whom inspected, when inspected, conditions of netting when inspected, and other details. Not only that, but officials of the road make surprise tests by opening the front ends of engines and inspecting nettings after employees who are charged with this duty have finished, the purpose of this being to ascertain if the inspectors have been careful in their investigation."

Throughout the State nearly all the railroads take precautionary measures, by cleaning up their rights of way, more or less thoroughly. They are beginning to find out the more thoroughly this is done the greater protection they secure. It is becoming apparent that whatever measures the State hereafter may take to prevent fires they will secure sympathetic consideration from the railroads in regard to any proposition for coöperation which the State may make.

CO-OPERATION OF POSTAL EMPLOYEES

Mail Carriers to Report Forest Fires:

In July, 1915, soon after the approval of the Weeks Law agreement, the State Forester was notified by the U. S. Forest Service that the Postmaster General's new order requiring rural and star route mail carriers to report forest fires to the properly designated forest officer would in the future apply to North Carolina.

This was made possible by the passage of the Forestry Law and the approval of the Weeks Law agreement between the State Geological Board and the Federal Government by means of which actual forest fire protection might be started in North Carolina. The Postmaster General's order, dated Washington, D. C., July 12, 1915, reads as follows:

The attention of postmasters and rural and star-route carriers is directed to the following order:

ORDER No. 9006.

The following instructions are promulgated for the guidance of the postal employees concerned:

In accordance with the request of the Secretary of Agriculture, this Department has arranged a plan of coöperation with the State and National Forest officers whereby rural and star-route carriers shall report forest fires discovered by them along their routes to persons designated by the State and National authorities to receive such intelligence.

Coöperation with State officers will be given in all states which have established by law a system of forest fire protection.

Coöperation will be furnished National Forest officers in all States containing National Forests.

The State and National authorities will inform postmasters as to whom the discovery of fires should be reported, and each rural carrier should be directed to coöperate to the fullest extent with such authorities in the manner agreed upon, namely, that the carrier shall report a fire to the nearest State fire warden or National Forest officer on his route, or, if no such warden or officer lives on the route, to arrange through some responsible citizen to have him notified, by telephone if possible. Star-route contractors and carriers are included in the plan of coöperation and should be requested to report the discovery of fires in the same manner as will be done by the rural carriers.

Postmasters in or near National Forests are also directed to report fires to the nearest forest officer.

(Signed) A. S. BURLISON,
Postmaster General.

This order was printed in the August supplement of the Official Postal Guide of that year. It has since been in application in all parts of the State where organized fire protection has been in effect, that is, where there have been proper officials to whom reports of fires could be made. In appointing Federal patrolmen and State wardens they are always instructed to keep in touch with mail carriers and to arrange for the quick and effective reporting of fires.

Posting Notices in Postoffices:

In September, 1915, the Postmaster General acceded to the request of the United States Forest Service that postmasters be allowed and instructed to post at least one fire warning notice in the lobby of the postoffice at the request of State or Federal Forest officers. At the same time he prescribed the proper method of securing the coöperation of local postmasters for this service. Should Federal patrolmen or State Forest Wardens at any time meet with difficulty in securing such coöperation with postmasters, they are advised to take the matter up with the State Forester.

STATE LEGISLATION NEEDED

The Forestry Bill of 1915, as introduced into the General Assembly, called for an appropriation of \$20,000 for carrying out the provisions of the act. This appropriation, however, was cut out in committee and the bill was passed without it.

At the urgent request of the North Carolina Forestry Association and of the North Carolina Geological and Economic Survey, an appropriation bill asking for the same amount was introduced into the Legislature of 1917. This bill obtained the support of most of the strongest men in the Legislature and would have been passed, after having the amount of the appropriation reduced from \$20,000 to \$5,000, had it not been for the fatal delay in reporting the measure to the House.

The following bill, which embodies the essential features of the previous proposed measure, is here suggested, and its passage respectfully urged:

A BILL TO BE ENTITLED AN ACT TO PROVIDE FOR CARRYING OUT THE PROVISIONS OF THE FOREST FIRE LAW

The General Assembly of North Carolina do enact:

SECTION 1. That in order to enable the Geological Board to carry out effectively the provisions of chapter two hundred and forty-three of the Public Laws of nineteen hundred and fifteen, relative to the forests of the State of North Carolina, and their protection from fire; and to enable the Geological Board to coöperate with the Federal Government in the protection of forests from fire, as authorized under the Weeks Act; there is hereby appropriated, out of any moneys in the Treasury not otherwise appropriated, the sum of ten thousand dollars annually, or as much thereof as may be necessary for the purpose of carrying out the provisions of this act, as directed by the Geological Board.

SEC. 2. This act shall be in force from and after its ratification.

SOME REASONS FOR DEMANDING A FORESTRY APPROPRIATION

1. From 1909-1917, inclusive, the average annual damage from forest fires in North Carolina was more than \$950,000, while during the spring of 1916 alone the damage amounted to nearly \$3,000,000.

2. Ninety-eight per cent of our fires are caused by human agency, and so are preventable.

3. The Forest Fire Law (chapter 243, Public Laws of 1915) is drafted along lines which have proved most effective in other states, and has been heartily approved by the United States Forest Service. The Chief of Coöperation in the Forest Service speaks of it as "A Forest Fire Law by means of which, if funds had been made available, one of the best protective systems in the United States could have been established."

4. Under this law forest wardens may be appointed when necessary in each township and district; fire patrols may be employed during danger periods; assistance may be summoned for fighting fires; and provision for compensation is made.

5. The administration of this law is put in the hands of the State Geological Board, which has available the necessary knowledge and experience for properly enforcing it.

6. Without any special appropriation the State Geological and Economic Survey has expended as large a share as possible of its regular appropriation for the enforcement of this law. Posters have been printed and distributed, landowners have been organized into fire protective associations, and private subscriptions have been received and disbursed for fire protection.

7. The Federal Government, under the Weeks Law, has coöperated by providing as much as \$1,000 and not more than \$2,000 a year for the payment of patrolmen. These have so far been appointed in the western part of the State so that the headwaters of streams would be protected, and because more active coöperation has been secured there.

8. If an appropriation can be secured from the Legislature, we have been promised a large increase in the apportionment from the Federal Government. At least \$4,000 might be expected from this source, and possibly \$7,000 or \$8,000. Unless, however, the State can provide funds for fire protection, we cannot expect any increase in Federal funds.

9. Only first-class men, respected in their community and familiar with their district, would be employed, the object being not only to extinguish fires but to secure the hearty coöperation of the local residents in fire prevention.

Public opinion, as represented by interested organizations and the leading newspapers of the State, was strongly in favor of this measure in 1917. It will, no doubt, be found almost unanimously behind this necessary appropriation for the prevention of forest fires in 1919.

ACTION URGED BY ORGANIZATIONS

The Appalachian Logging Congress which met in Asheville, April 28-29, 1916, passed the following resolution:

"That this Congress goes on record as heartily in favor of and willing to support the Federal and State governments in fire protective policies, especially urging upon its members hearty coöperation with the State Forester of North Carolina."

The *Linville Forest Protective Association* at its annual meeting at Linville, October 3, 1916, unanimously adopted the following resolutions:

"Whereas the Linville Forest Protective Association has been organized for the purpose of protecting the lands of its members from fire; and

"Whereas our own experience as members of this association, as well as that of others engaged in similar work, has convinced us that all forces must coöperate to the fullest extent to make fire prevention effective; and

"Whereas the Federal Government not only adequately patrols its own lands which border those covered by this association, but under the Weeks Law offers to assist in fire protection in proportion to the work along this line done by the State; therefore, be it

"Resolved, That the General Assembly of North Carolina soon to be elected be hereby respectfully requested to provide an adequate appropriation for carrying out the provisions of the new State Forest Fire Law, thereby enabling the State to meet the requirements of the Weeks Law so that greatly increased financial assistance may be secured from the Federal Government."

Later the manager of this association, Mr. J. P. Gibbs, wrote to his representative at Raleigh urging an appropriation. He concluded his letter as follows:

"With the Federal Government coöperating in this work and the citizens of some sections actively engaged, is it not the duty of the State through its Legislature to provide means with which to coöperate in protecting its forest resources from which it

derives revenue? I hope your honorable Assembly will give this matter the attention that its importance requires."

The *Southern Forestry Congress* which met in Asheville, July 11-15, 1916, among a number of resolutions dealing with different phases of forestry, indorsed the following:

"Whereas progress in State Forestry requires not only an effective nonpolitical organization at its head, but also sufficient funds to carry on the important work of popular education in forestry, establishment of organized fire protection, assistance to woodland owners in the management of their property, checking erosion, and supervision of such State forests as may be established; and

"Whereas many Southern states which have already made an excellent beginning by the establishment of forestry departments are as yet without adequate financial support; therefore, be it

"*Resolved*, That the Southern Forestry Congress urges upon the legislatures of the respective states a more liberal policy in providing funds for the conduct of forestry work, and in passing such additional legislation as may be necessary to make this work effective in practice."

The *North Carolina Press Association* at its annual meeting in Durham, July, 1916, drew up and adopted a resolution calling upon the General Assembly to enact a practical and an intelligent Forestry Law, which should contain provisions for the appointment of Forest Fire Wardens in each county of the State, with proper compensation, etc. The passage of such a measure, the editor of the *Southern Lumber Journal* of Wilmington, N. C., contends, would mean a saving of thousands and of hundreds of thousands of dollars annually to the Southern states and lengthen the life of our timber resources many years.

The *North Carolina Forestry Association* at its annual meeting in Raleigh, January 25, 1917, urged an appropriation for forestry in the following resolution:

"*Resolved*, That the North Carolina Forestry Association urges the members of the General Assembly to support the bill now pending before that body making an appropriation to the Geological Board for carrying out the provisions of the Forest Fire Law, for making experimental forests, and for other forestry work authorized by law.

"*Resolved further*, that this association, appreciating the work that the North Carolina Geological and Economic Survey has done and is now doing in the interest of the preservation and conservation of our forests, pledges its support to the further efforts of this department."

CONSTRUCTIVE LEGISLATION DEMANDED BY THE STATE PRESS

CARE OF OUR FORESTS

. . . The case is a very simple one. We have the laws. We should have the money needed to establish the enforcement of these laws. The Forestry Association will ask this of the Legislature next winter, and that body surely will be moved to put life into the laws. The statute as it stands has a good moral effect; other than that it is useless. We are not advised as to the amount of the appropriation the Forestry Association will ask, but it will not be one of a formidable character. We feel sure of one thing, however, in knowledge of the extent of the yearly devastation of woods by fires, that the sum agreed upon will be well within the bounds of the necessities of the cause.—*Charlotte Observer*, November 22, 1916.

WHEREIN MILLIONS ARE INVOLVED

The North Carolina Geological and Economic Survey presented convincing facts and figures, five years ago, showing that the application of proved principles and practices

of fire protection and reforestation in Western North Carolina would insure the permanence of supplies for the pulp, acid, and hardwood industries of that region, and permit of their substantial increase within a few years. Millions are involved.

Nothing was done about it; that is, nothing beyond a rhetorical addition to the statute books. Nothing more was done about it by the people directly concerned, or by the Legislature; but it must be added that in coöperation with the United States Government the Survey has lately diverted money from its general fund—money badly needed for other purposes—to some work in this direction.

Will anything be done about it, we wonder? It means millions of dollars worth of resources saved, therefore, millions made.—*Greensboro Daily News*, Nov. 25, 1916.

FOREST FIRES

Something has been done towards forest preservation, both from the hungry flames and the still hungrier lumberman, but little more than a mere start has been made. This conservation work is worth spending much more money on than has yet been appropriated for it.—*Gastonia Gazette*, May, 1916.

THE FOREST FIRES

The experiences of the present spring ought to give the people of North Carolina a better appreciation of the forestry laws and the necessity for their observance. It is scarcely less important for the people of the State to fight fires in the woods than it is to fight fires in the towns.—*Charlotte Observer*, April 25, 1916.

THE MENACE OF FOREST FIRES

In nearly every state now the law prescribes fine or imprisonment for carelessly starting or causing a forest fire. Let these laws be enforced. Every farmer should help indict the guilty, and, when on juries, help convict them.—*Progressiv Farmer*, November 25, 1916.

PROTECTION FOR FORESTS

If the Forest Law now on the statute books will in the judgment of the legislators afford any protection by being carried out, it would be wise to make an appropriation to that end. If it does not appear to be a good and sufficient one, let the Legislature pass a law that will do the work. Ten thousand dollars is a small amount to appropriate for protection from forest fires, especially when it is remembered that at least that amount has been lost in Cumberland County alone this spring.—*Fayetteville Observer*, May 10, 1916.

THE RAVAGE OF THE WOODS

The experiences of North Carolina this spring with the ravaging forest fires ought to inspire a stricter observance of the laws for the protection of the forests, bringing the people into a greater realization of their importance.—*Charlotte Observer*, May 11, 1916.

RAVAGE OF THE FORESTS

. . . The least the Legislature can do is to provide an appropriation that will give the work of forestry protection a start. The building up of a protective system cannot be done in a year, but it can be initiated at the coming session of the General Assembly.—*Charlotte Observer*, December 3, 1916.

A LITTLE MONEY BALKING

The State is provided with an excellent set of forestry laws, but there is no money back of these laws, and they might as well not be on the statute books. If the money asked for is made available, we feel quite sure that it would be repaid a hundredfold

to the State in the shape of forests protected from destruction.—*Charlotte Observer*, February 20, 1917.

AN INVESTMENT OPPORTUNITY

A bill has been introduced to complete the work of the 1915 Assembly by appropriating \$20,000 annually for the purpose of carrying out the provisions of the fire protection act. It is safe to assume that if the work had been done properly by the former Legislature the \$40,000 that would have been expended would have yielded not less than 100 per cent. The total damage for one fiscal year ran well over half a million dollars. The opportunity was presented to the Geological and Economic Survey, if it had had means with which to work, for saving the cost of that means many times over. Is it, in fact, a good law, adequate to its purpose? The only way to find out is to give it a trial. The experience of other states indicates that this will be an investment returning enormous profits to the State. Twenty thousand dollars is an inconsiderable sum compared to an average annual forest-fire loss running above \$600,000. The Survey would have to cut the loss down only one-twelfth to prove the \$20,000 a splendid investment. . . .

If North Carolina were a private corporation, it would be expending millions upon the forests within its area. It would be setting aside entire stream basins in the Mountain and Piedmont sections for experimental schemes, to determine to what extent stream flow and other factors of agriculture may be controlled through conditions at the headwaters. It would be reforesting all untillable lands as rapidly as possible, and all timber areas would be so adequately guarded that fires would be practically unknown.—*Greensboro Daily News*, February 20, 1917.

It is confidently hoped that an appropriation will be made by the Legislature of 1919 as a war measure. The reduction of available labor throughout the State which can be called upon to fight fires greatly increases the fire risks. It therefore seems essential that some definite steps be taken to meet this emergency, and such steps can only be taken after an appropriation has been provided.

APPENDIX

**List of Counties and Townships in North Carolina, together with the
Names and Postoffice Addresses of the Voluntary Township Forest-
Fire Correspondents Reporting for the Year 1917**

VOLUNTARY TOWNSHIP FOREST FIRE CORRESPONDENTS IN NORTH CAROLINA REPORTING FOR 1917

MOUNTAIN REGION

ALLEGHANY

<i>Cherry Lane</i>	J. T. Miles	Cherry Lane
	G. W. Miles	Miles
	O. O. Smith	Laurel Branch
<i>Cranberry</i>	J. M. Blevins	Gray
	John A. Long	Laurel Springs
	J. J. Miller	Laurel Springs
<i>Gap Civil</i>		
<i>Glade Creek</i>	A. O. Carico	Edmonds
<i>Piney Creek</i>	C. L. Hash	Piney Creek
<i>Prathers Creek</i>	N. C. Shepherd	Scottville
<i>Whitehead</i>	Wiley Combs	Whitehead

ASHE

<i>Chestnut Hill</i>	I. E. Gambill	Crumpler
	J. F. Oliver	Crumpler
<i>Clifton</i>	J. C. Raland	Clifton
<i>Creston</i>	J. R. McMillan	Creston
<i>Grassy Creek</i>	Eli Francis	Grassy Creek
<i>Helton</i>	Charles F. Sexton	Grassy Creek
<i>Horse Creek</i>		
<i>Jefferson</i>	Geo. F. Bare	Wagoner
<i>Laurel</i>	A. W. Long	Grayson
	W. E. Perry	Grayson
<i>North Fork</i>	L. J. Sturgill	Parker
<i>Obids</i>	J. C. Bowlin	Glendale Springs
	D. H. Burgess	Obids
<i>Old Fields</i>		
<i>Peak Creek</i>	G. B. Austin	Laurel Springs
	W. L. Miller	Laurel Springs
	W. N. G. Wellborn	Laurel Springs
	E. B. Shepherd	Flow
<i>Pine Swamp</i>	Virgil L. Maretz	Hopkins
<i>Piney Creek</i>		
<i>Walnut Hill</i>		

AVERY

<i>Altamont</i>	W. C. Franklin	Altamont
<i>Banners Elk</i>	T. L. Lowe	Banners Elk
<i>Beech Mountain</i>	L. W. McGuire	Whaly
	J. H. Walsh	Dark Ridge
<i>Cranberry</i>		
<i>Linville</i>	J. L. Hartley	Linville
<i>Roaring Creek</i>	R. T. Lewis	Valley
<i>Toe River</i>		
<i>Wilson Creek</i>		

BUNCOMBE

<i>Asheville</i>	J. M. English & Co.	Asheville
	W. Haynes	Asheville
<i>Averys Creek</i>	M. S. Glenn	Arden
<i>Beaverdam</i>		
<i>Biltmore</i>		
<i>Black Mountain</i>	W. H. Burnett	Black Mountain
<i>Fairview</i>	Jason Ashworth	Fairview
<i>Flat Creek</i>		
<i>French Broad</i>	G. H. Blankenship	Alexander
<i>Haw Creek</i>	J. A. Gwaltney	Asheville
<i>Hazel</i>		

BUNCOMBE—Continued

<i>Ivy</i>	M. T. Arrowood	Democrat
	J. O. Brigman	Dillingham
	J. H. Woodward	Democrat
<i>Leicester</i>		
<i>Limestone</i>		
<i>Lower Hominy</i>		
<i>Reems Creek</i>		
<i>Sandy Mush</i>	A. L. Ingle	Odessa
<i>Swannanoa</i>	W. R. Alexander	Swannanoa
<i>Upper Hominy</i>	J. C. Byrd	Candler
	J. C. Curtis	Candler, R. 3
	J. C. Waters	Candler

BURKE

<i>Icard</i>	G. L. Stine	Hildebran
<i>Jonas Ridge</i>	G. A. Loven	Cold Spring
	F. W. Bicknell	Linville Falls
<i>Linville</i>	J. K. Giles	Fonta Flora
<i>Lovelady</i>	P. A. Bollinger	
	J. E. Cautler	Connellys Springs
	D. W. Lowman	Connellys Springs
	J. M. Abree	Waldese
<i>Lower Creek</i>	W. P. Corpening	Worry
	J. V. Powell	Morganton
<i>Lower Fork</i>		
<i>Morganton, No. 1</i>		
<i>Morganton, No. 2</i>		
<i>Quaker Meadow</i>		
<i>Silver Creek</i>	A. H. Conley	Morganton, R. 1
	J. A. Wainwright	Morganton, R. 1
<i>Smoky Creek</i>	E. H. Tilley	Morganton, R. 2
<i>Upper Creek</i>	M. S. Arney	Worry
	T. C. Berry	Morganton
	S. L. Denton	Morganton, R. 4
<i>Upper Fork</i>		

CALDWELL

<i>Globe</i>	B. A. Crump	Globe
	James Moore	Globe
	J. R. Moore	Globe
<i>Hudson</i>	John A. Bush	
<i>Johns River</i>	W. T. Mays	Lenoir, R. 4
	Geo. T. Perkins	Adako
	J. Calvin Coffey	Lenoir, R. 4
<i>Kings Creek</i>	G. M. Icenhour	Grandin
	Pickens Barlow	Kings Creek
	G. H. Carter	Kings Creek
<i>Lenoir</i>	W. C. Moore, Jr.	Lenoir
	W. L. Swanson	Lenoir, R. 3
	G. A. Tuttle	Lenoir, R. 5
<i>Little River</i>	Fred M. Deal	Lenoir, R. 2
	F. E. Story	Lenoir
<i>Lovelady</i>	G. W. Sherrill	Granite Falls
<i>Lower Creek</i>		
<i>North Catawba</i>	A. Canon Craig	Lenoir, R. 3
	D. N. W. Smith	Granite Falls
<i>Patterson</i>	Charles J. Dobbins	Finley
	John R. Hagaman	Patterson

CALDWELL—Continued

<i>Patterson</i>	T. S. Setser	Patterson
<i>Wilsons Creek</i>	J. Roby Hayes	Mortimer
<i>Yadkin Valley</i>	D. R. S. Frazier	Kings Creek
	R. L. Miller	Buffalo Cove

CHEROKEE

<i>Beaverdam</i>	R. L. Hampton	Unaka
	A. Z. Roberts	Grandview
<i>Hothouse</i>		
<i>Murphy</i>	J. T. Hayes	Tomatla
	T. C. McDonald	Murphy
<i>Notla</i>	A. H. Davidson	Letitia
	B. L. Fox	Ranger
<i>Shoal Creek</i>		
<i>Valleytown</i>	S. H. Parker	Marble
	R. A. Dewar	Andrews

CLAY

<i>Brasstown</i>	T. B. Hampton	Brasstown
	Fred O. Scroggs	Brasstown
	George R. Sharp	Brasstown
<i>Hayesville</i>	W. T. Bumgarner	Hayesville
<i>Hiawassee</i>	J. A. Chambers	Hayesville
	Ernest D. Penland	Hayesville
<i>Shooting Creek</i>	N. N. Rogers	Shooting Creek
<i>Tusquittee</i>	A. G. Moore	Hayesville
	J. V. A. Moore	Hayesville
	Ed. T. Shearer	Hayesville

GRAHAM

<i>Cheoah</i>	E. H. Potter	Topton
<i>Stecoah</i>		
<i>Yellow Creek</i>	J. M. English	
	J. L. Green	Fontana

HAYWOOD

<i>Beaverdam</i>		
<i>Cataloochee</i>	W. M. Sutton	Cataloochee
<i>Cecil</i>	H. P. Ledbetter	Canton, R. 2
<i>Clyde</i>		
<i>Crabtree</i>	F. A. Justice	Clyde, R. 1
	A. J. McCracken	Clyde, R. 1
	J. L. Walker	Clyde, R. 1
	C. E. Williams	Crabtree
<i>East Fork</i>	Gwyn Grill	Cruso
	W. R. Grogen	Cruso
	S. L. Grogen	Springdale
	B. F. Sellers	Cruso
<i>Fines Creek</i>	George A. Brown	Crabtree
<i>Iron Duff</i>	T. N. Crawford	Waynesville
	J. S. Davis	Waynesville, R. 2
<i>Ivy Hill</i>		
<i>Jonathan Creek</i>	Robert Harrell	Waynesville
	E. J. Howell	Waynesville, R. 2
<i>Pigeon</i>	Wm. Ledbetter	Canton, R. 2
	Ira Mease	Canton, R. 2
	W. W. Wilson	Canton, R. 2
<i>Waynesville</i>		
<i>White Oak</i>	Zack Clark	Teague

HENDERSON

<i>Blue Ridge</i>	A. K. Hyder	Saconon
<i>Clear Creek</i>	R. M. Pryor	Hendersonville, R. 2
<i>Crab Creek</i>		
<i>Edneyville</i>	T. Q. Ledbetter	Edneyville
	T. A. W. Lyda	Edneyville

HENDERSON—Continued

<i>Edneyville</i>	C. Oates	Bear Wallow
	Lonnie R. Rhodes	Hendersonville, R. 2
<i>Green River</i>	W. F. Pace	Zirconia
<i>Hendersonville</i>	A. Cannon	Horse Shoe
	John Eubanks	Hendersonville
	C. Whitaker	Hendersonville, R. 5
<i>Hoopers Creek</i>	J. P. Fletcher	Fletcher
	J. V. Russell	Fletcher
<i>Mills River</i>	J. H. Murray	Horse Shoe
	J. P. Whitaker	Horse Shoe

JACKSON

<i>Barkers Creek</i>		
<i>Canada</i>	S. M. Parker	Tuckaseigee
	W. T. Rigdon	Argura
	John H. Smith	Wolf Mountain
<i>Caney Fork</i>	W. H. Hooper	Cowarts
	G. F. Nicholson	Cowarts
<i>Cashiers</i>	C. G. Rogers	Cashiers
	T. R. Zachary	Cashiers
<i>Cullowhee</i>	T. C. Ledbetter	Cullowhee
<i>Dillsboro</i>		
<i>Greens Creek</i>	J. C. Reed	Greens Creek
<i>Hamburg</i>	D. P. Moss	Glenville
	L. A. Wilson	Big Ridge
<i>Mountain</i>	W. R. Stewart	Erastus
<i>Qualla</i>		
<i>River</i>		
<i>Savannah</i>	P. N. Price	Tuckaseigee
<i>Scotts Creek</i>		
<i>Sylva</i>	W. T. Derrick	Balsam
<i>Webster</i>	Walter E. Moore	Webster

MACON

<i>Burningtown</i>	W. M. Edwards	Franklin, R. 3
	C. S. Ray	Franklin
	Robert Ramsey	Tellico
<i>Cowee</i>	John H. Dalton	Iotla
	W. J. Jenkins	Wests Mill
<i>Cartoogechaye</i>		
<i>Ellijay</i>	N. L. Jollay	Cullasaja
<i>Flats</i>	R. H. Rogers	Scaly
	J. E. Vinson	Scaly
<i>Franklin</i>	N. L. Barnard	Franklin
<i>Highlands</i>	J. R. Phillips	Shortoff
	J. Q. Pierce	Highlands
	Barry C. Hawkins	Highlands
<i>Millshoal</i>	Elias V. Ammons	Franklin
<i>Nantahala</i>	Joseph W. Gregory	Lookout
<i>Smith Bridge</i>	C. R. Cabe	Otto
<i>Sugar Fork</i>	J. M. Keener	Scroll

MADISON

<i>No. 1</i>	John S. Rice	Walnut
	W. C. Sprinkle	Marshall
<i>No. 2</i>		
<i>No. 3</i>	Thomas G. Murray	Marshall, R. 3
<i>No. 4</i>	Levi Hamlin	Buckner
	W. B. Holcomb	Waverly
<i>No. 5</i>	Miss Flossie Murray	Mars Hill
<i>No. 6</i>	Wiley L. Carver	Marshall
<i>No. 7</i>	James J. Ledford	Marshall, R. 5
	R. F. Payne	Marshall
	Wiley M. Roberts	Marshall, R. 5
<i>No. 8</i>		
<i>No. 9</i>	D. H. Gardner	Paintcrck
<i>No. 10</i>		

MADISON—Continued

No. 11	E. E. Bryan	Faust
	W. M. English	Faust
	R. W. Rice	
No. 12	W. B. Randall	Barnard
	Jacob R. Worley	Worley
No. 13	J. E. Gregory	Joe
	W. A. Norris	Joe
	T. H. Stormy	Joe
No. 14	J. F. Tilson	Marshall, R. 2
No. 15	J. A. Ramsey	Mars Hill
No. 16	C. W. Cody	Flag Pond, Tenn.

McDOWELL

Bracketts		
Broad River	H. W. Miller	Black Mountain
	W. L. Nanney	Black Mountain
	C. M. Nanney	Black Mountain
Crooked Creek	A. B. Burger	Old Fort
Dysartsville	John B. Kirksey	Dysartsville
	Robert F. Sisk	Nebo, R. 1
	E. G. Goforth	Nealsville
Glenwood	L. A. Haney	Nealsville
Higgins	Peter Cannon	Marion, R. 2
Marion	W. L. Ferguson	Marion
	D. A. Snipes	Garden City
Montfords Cove	C. R. Wilkerson	Nealsville, R. 1
Nebo		
North Cove	J. B. Lorrion	Ashford
Old Fort	J. H. Young	Old Fort

MITCHELL

Bakersville	W. G. Bowman	Bakersville
Bradshaw		
Cane Creek	T. A. Buchanan	Hawk
Fork Mountain	D. M. Cook	Bakersville, R. 1
Grassy Creek	R. B. Harrison	Spruce Pine
	J. M. Peterson	Spruce Pine
Harrell	W. B. Honeycutt	Magnetic City
	Isaac McKinney	Ewart
Little Rock Creek	Cain Freeman	Glen Ayre
Poplar	Billie Peterson	Poplar
	Hiram Tipton	Poplar
Red Hill	S. H. Bryant	Brummett
	J. W. Howell	Green Mountain
Snow Creek	M. V. Buchanan	Ledger, R. 1

POLK

Columbus	J. G. Hughes	Columbus
Cooper Gap	W. W. Gibbs	Mill Spring
	W. G. Hill	Saconon
Greens Creek	W. M. Barnett	Landrum, S.C., R. 1
	Robert L. Camp	Rutherfordton, R. 2
	J. W. McFarland	Rutherfordton, R. 1
Saluda	Henry P. Corwith	Saluda
	Thomas E. Pace	Fish Top
	G. W. Pearson	Rockliff
Tryon	James M. Butler	Tryon, R. 1
	D. E. Conner	Tryon
White Oak		

RUTHERFORD

Camp Creek		
Chimney Rock	J. M. Flack	Chimney Rock
	Paul F. Searcy	Uree, R. 1
	M. A. Searcy	Mill Springs, R. 2
	J. C. Williams	Uree, R. 1

RUTHERFORD—Continued

Colfax		
Cool Springs	S. A. Bridges	Forest City
	Lee W. Lynch	Forest City
Duncans Creek		
Gilkey	W. F. Doggett	Gilkey
	J. D. Fincannon	Gilkey
Golden Valley		
Green Hill	R. Ledbetter	Uree
High Shoals		
Logans Store	J. B. Dill	Bostic, R. 2
	W. G. Grayson	Bostic
Morgan	W. J. Hardin	Rutherfordton, R. 3
	L. D. Hemphill	Union Mills, R. 1
Rutherfordton		
Sulphur Springs	Lloyd Williams	Harris
Union	J. M. Owens	Rutherfordton, R. 1

SURRY

Bryan	B. J. Snow	State Road
	J. L. Thompson	Devotion
Dobson	J. F. Nance	Dobson
Eldora		
Elkin	Mrs. W. M. Cuncliff	Elkin
	L. C. Park	Elkin, R. 1
Franklin	I. F. Armfield	Low Gap
	G. E. Isaacs	Dobson, R. 1
	J. M. Todd	Low Gap
Long Hill	F. A. Ashburn	Mount Airy
	P. W. Bryant	Ararat
	S. M. Stone	Mount Airy, R. 1
Marsh	H. E. Beaman	Rusk, R. 1
	J. H. Poindexter	Crutchfield
	T. A. Stanley	Rusk
Mount Airy	J. R. McKinny	Mount Airy
	J. A. Sparger	Mount Airy
Pilot	D. J. Denny	Pinnacle, R. 3
	Job Hiatt	Pilot Mountain
	R. H. Redman	Pilot Mountain
	W. H. Reid	Pilot Mountain
Rockford	J. G. Burrus	Rockford
Shoals	M. F. Butner	Pinnacle, R. 1
	O. F. Hauser	Shoals
	C. W. Key	Pinnacle
	R. S. Scott	Shoals
Siloam	R. N. Marion	Siloam
Stewarts Creek	J. H. East	Mount Airy, R. 3
	I. W. Reece	Mount Airy, R. 3
Westfield	Thomas L. Brim	Brim
	P. H. Jessup	Brim
	H. E. Taylor	Pilot Mountain, R. 2
	W. W. Wamburn	Mount Airy, R. 1

SWAIN

Charleston	D. De Hart	Bryson City
	G. W. McCracken	Bryson City
Nantahala		
Forneys Creek	G. I. Calhoun	Proctor
Ocona Lufly		

TRANSYLVANIA

Boyd	John S. Boggs	Brevard, R. 2
Brevard	T. L. Gash	
Catheys Creek	J. M. Zachary	Calvert
	Harry C. Fenwick	Selica
Dunns Rock	G. W. Whitmore	Brevard, R. 1
Estatoe		

TRANSYLVANIA—Continued

<i>Gloucester</i>	Jesse M. McCall	Balsam Grove
	J. W. Owen	Lake Toxaway, R. 1
<i>Hogback</i>	T. C. McCall	Quebec
<i>Little River</i>	A. J. Beddingfield	Etowah, R. 1

WATAUGA

<i>Bald Mountain</i>	C. M. Blackburn	Brookside
<i>Beaver Dam</i>	S. C. Eggers	Vilas
	Smith Hagaman	Vilas
<i>Blowing Rock</i>	L. S. Bollinger	Blowing Rock
	R. K. Hartley	Blowing Rock
<i>Blue Ridge</i>		
<i>Boone</i>	T. L. Critcher	Bamboo
	W. D. Farthing	Boone
<i>Cove Creek</i>	N. L. Mast	Mast
<i>Elk</i>	J. W. Hayes	Triplet
<i>Laurel Creek</i>	D. C. Mast	Sugar Grove
<i>Meat Camp</i>	W. W. Norris	Sands
<i>North Fork</i>	J. M. May	Trade, Tenn., R. 2
	J. O. J. Potter	Tamarack
	F. M. Thomas	Trade, Tenn.

Shawneehaw
Stony Fork
Watauga

J. F. Church Shulls Mills

WILKES

<i>Antioch</i>	Simon Curry	Call
	L. M. Jarvis	Roaring River
<i>Beaver Creek</i>	T. J. James	Ferguson
	V. McGlimmis	Boomer
	W. J. St. Clair	Boomer, R. 2
<i>Boomer</i>	John E. Phillips	Boomer
<i>Brushy Mountain</i>	J. J. Hendren	Gilreath
<i>Edwards</i>	C. F. Fields	Elkin
	P. A. Lomax	Lomax
	E. W. Settle	Benham
<i>Elk</i>	G. W. Welch	Mount Zion
<i>Jobs Cabin</i>	J. W. Church	Summit
<i>Lewis Fork</i>	E. C. Foster	Purlear
	W. G. Foster	Champion
	B. C. Triplett	Marley Ford

ALAMANCE

<i>Albright</i>		
<i>Boone Station</i>		
<i>Coble</i>	Green A. Nicholson	Burlington, R. 1
	J. F. Homewood	Burlington
<i>Faucett</i>		
<i>Graham</i>	Lewis H. Holt	Graham
	H. J. Stockard	Graham
	J. M. McCracken	Graham
<i>Haw River</i>		
<i>Melville</i>		
<i>Morton</i>	J. T. Bowles	Altamahaw, R. 2
	L. D. Rippy	Altamahaw
<i>Newlin</i>	R. F. Moore	Saxapahaw
<i>North Burlington</i>		
<i>Patterson</i>	R. J. Thompson	Rock Creek, R. 2
	R. Z. Hornaday	Rock Creek, R. 2
<i>Pleasant Grove</i>	S. E. Tate	Mebane
	W. B. Sellers	Mebane, R. 3
<i>South Burlington</i>		
<i>Thompson</i>	H. G. Paris	Graham, R. F. D.
	W. M. Overman	Graham, R. 2
	H. M. Cates	Graham, R. 2

WILKES—Continued

<i>Lovelace</i>	Parks M. Reid	Spurgeon
	T. A. Triplett	Hunting Creek
	C. C. Wright	Hunting Creek
	R. V. Wright	Hunting Creek
<i>Moravian Falls</i>	W. G. Meadows	Moravian Falls
<i>Mulberry</i>	H. H. Jennings	N. Wilkesboro, R. 1
<i>New Castle</i>	G. W. Sale	Ronda
	C. M. Welborn	New Castle
<i>North Wilkesboro</i>	Leonard Vyne	North Wilkesboro
<i>Reddies River</i>	O. L. Foster	Congo
<i>Rock Creek</i>	W. N. Alexander	North Wilkesboro
	A. B. Hays	Hays
<i>Somers</i>	S. A. Mitchell	New Castle
<i>Stanton</i>	H. O. Parsons	Purlear
<i>Traphill</i>	G. M. Brown	Traphill
<i>Union</i>	C. H. Colvard	Wilbar
	W. H. Joines	Wilbar
	David Roten	Sherman
<i>Walnut Grove</i>	W. L. Brewer	Brewers
<i>Wilkesboro</i>	H. H. Moorehouse	Oakwoods
	W. D. Woodruff	Wilkesboro

YANCEY

<i>Burnesville</i>	J. M. Banks	Anatone
<i>Cane River</i>	Gus F. Hensley	Bald Creek
	Z. P. King	Wampler
	R. A. Radford	Cane River
	W. J. Waycaster	Bald Creek
<i>Crabtree</i>	J. G. Marsh	Bowditch
	A. B. Silver	Micaville
	N. N. Silver	Micaville
<i>Egypt</i>	D. M. Buck	Bald Mountain
<i>Green Mountain</i>	D. C. Renfro	Toledo
<i>Jacks Creek</i>	B. T. Horton	Burnsville, R. F. D.
	Carl Young	Day Book
<i>Prices Creek</i>	P. S. Casida	Burnsville
	J. D. Robinson	Paint Gap
	W. B. Wray	Cane River
<i>Pensacola</i>		
<i>Brush Creek</i>		
<i>Ramseytown</i>	J. A. Hannum	Ramseytown
<i>South Toe</i>	C. R. Harrison	Celo

PIEDMONT REGION

ALEXANDER

<i>Ellendale</i>		
<i>Gwaltneys</i>		
<i>Little River</i>		
<i>Miller</i>	J. T. Hedrick	Stony Point, R. 3
<i>Sharpes</i>	T. F. Murdock	Hiddenite
	A. A. Somers	Stony Point
<i>Sugar Loaf</i>	J. P. Russell	Taylorsville
<i>Taylorsville</i>	I. A. Barnes	Taylorsville
<i>Wittenburg</i>		

ANSON

Ansonville
Burnsville
Gulledge
Lanesboro
Lilesville
Morven
Wadesboro
White Store

CABARRUS

No. 1		
No. 2		
No. 3	C. H. Hamilton	Davidson
No. 4	F. W. Glass	Glass
No. 5	L. J. Sapp	Concord, R. 3
No. 6	G. M. Cress	Concord, R. 4
No. 7	J. W. Honeycutt	Gold Hill, R. 3
	C. L. Earnhardt	Gold Hill
No. 8	L. A. Lipe	Mount Pleasant
No. 9	D. Milas Coley	Georgeville
	George C. Shinn	Georgeville
No. 10	John S. Turner	Stanfield
No. 11		
No. 12		

CASWELL

Anderson		
Dan River	D. G. Watkins	Blanch
Hightowers	J. L. Warren	Hightowers
Leasburg		
Locust Hill		
Milton	W. O. Smith	Milton, R. 1
Pelham	J. A. Brackin	Danville, Va., R. 5
	T. J. Martin	Pelham
Stony Creek		
Yanceyville	F. G. Harrelson	Yanceyville
	J. W. Wiggins	Yanceyville

CATAWBA

Bandys	William Hoyle	Reepsville
Caldwell	T. L. Bandy	Catawba
Catawba	A. L. Loftin	Catawba
Clines	P. L. Smyre	Claremont
	J. H. C. Huitt	Catawba
	G. W. Winebarger	Canover
Hickory	W. P. Bowman	Hickory, 647 High-land Ave.
	A. K. Joy	Hickory
Jacobs Fork	E. M. Yoder	Hickory
Mountain Creek		
Newton	J. Y. Killian	Newton

CHATHAM

Albright	W. J. Thompson	Siler City, R. 1
Baldwin	C. A. Snipes	Bynum, R. 1
	G. G. Ward	Bynum
	J. L. Glosson	Bonlee
Bear Creek		
Cape Fear		
Center	James L. Griffin	Pittsboro
	W. H. Hearne	
Gulf	Rev. G. C. Phillips	Bear Creek
Hadley		
Haw River		
Hickory Mountain		
Matthews	D. Talmage Siler	Siler City, R. 2
New Hope		
Oakland		
Williams	W. T. Hunt	Apex

CLEVELAND

No. 1		
No. 2	E. B. Hamrick	Boiling Springs
No. 3		
No. 4	H. W. Gallinure	Kings Mountain
No. 5	S. C. Lattimore	Shelby
	T. L. Hord	Waco
	C. C. Bram	Waco

CLEVELAND—Continued

No. 5	S. L. Dellinger	Waco
No. 6	Joe E. Blanton	Shelby
No. 7	J. B. Lattimore	Lattimore
No. 8		
No. 9	J. W. Grigg	Lawndale
No. 10	J. M. Carpenter	Belwood
	John T. Warlick	Belwood, R. 1
No. 11	J. F. Logan	Casar
	L. H. Bumgardner	Casar

DAVIDSON

Abbots Creek	A. H. Michael	Chandler
Alleghany	F. M. Cook	Newsom
	C. W. Stokes	Newsom
Arcadia		
Boone		
Conrad Hill	Oscar F. Hughes	Light
Cotton Grove	O. L. Stoner	Southmont
Emons		
Hampton	W. L. Davis	Clemmons, R. 2
Healing Springs	J. A. Kinney	High Rock
	D. G. Smith	High Rock, R. 1
Jackson Hill		
Lemelys	J. A. Boyles	Davidson
Lexington	H. L. Leonard	Lexington
Midway	R. E. Lambeth	Winston-Salem, R. 5
	James Nifong	Winston-Salem, R. 4
Reedy Creek		
Silver Hill	C. A. Hedrick	Lexington, R. 6
Thomasville	J. E. Meredith	Thomasville, R. 2
	J. W. Bowers	Thomasville, R. 1
Tyro	C. L. Hedrick	Davidson
	N. H. Swicegood	Linwood, R. 1
	H. H. Hartey	Lexington, R. 5
	Joe Sink	Lexington, R. 5
	F. F. Snyder	Linwood, R. 1
Yadkin College	Edward L. Greene	Yadkin College
	M. F. Phillips	Yadkin College

DAVIE

Calahaln	J. M. Ratledge	Calahaln
	J. H. Boyd	Calahaln
	W. S. Belk	Calahaln
	A. D. Ratledge	Calahaln
	Jesse L. Cartner	Mocksville, R. 1
Clarksville	D. R. Eaton	Cana
Farmington	M. J. Hendricks	Cana
Fulton	George T. Tucker	Advance, R. 2
Jerusalem	J. D. Goins	Cooleemee
Mocksville	D. C. Foster	Mocksville
	A. C. Kelly	Mocksville
Shady Grove	A. C. Wood	Advance

DURHAM

Carr		
Cedar Fork		
Durham	J. W. Ferrell	Durham, R. 2
	G. C. Stallings	Durham, R. 6
Lebanon		
Mangum	W. J. Young	Rougemont
Oak Grove		
Patterson	P. H. Massey	Durham, R. 3

FORSYTH

Abbots Creek	E. L. Carter	Kernersville
Belews Creek	A. W. Preston	Belews Creek
Bethania		

FORSYTH—Continued

<i>Broad Bay</i>	George W. Flynt W. R. Rominger	Winston-Salem 107 Flat Rock St., Winston-Salem Winston-Salem, R.5
<i>Clemmonsville</i>	C. H. Reed	
<i>Kernersville</i>	D. W. Harnon	Kernersville
<i>Lewisville</i>	E. B. Shouse	Clemmons, R. 1
<i>Middle Fork</i>	W. B. Cline	Winston-Salem, R.3
<i>Old Richmond</i>	J. R. Wall	Tobaccoville, R. 3
	O. V. Pfoff	Tobaccoville
<i>Old Town</i>		
<i>Salem Chapel</i>		
<i>South Fork</i>	J. M. Jarvis	Winston-Salem, R.1
<i>Vienna</i>	C. F. Micker	Pfafftown
<i>Winston</i>		
<i>West Salem</i>		

FRANKLIN

<i>Cedar Rock</i>	T. W. Stokes	Louisburg, R. 4
<i>Cypress Creek</i>	J. M. Sykes	Mapleville
<i>Dunns</i>		
<i>Franklinton</i>	J. O. Green	Franklinton
<i>Gold Mine</i>		
<i>Harris</i>	M. C. Wilder	Louisburg
	Z. L. Cheaver	Louisburg
	N. B. Young	Louisburg, R. 1
<i>Hayesville</i>	Kenneth Hawkins	Kittrell
<i>Louisburg</i>		
<i>Sandy Creek</i>	G. C. Parrish	Gupton
<i>Youngsville</i>		

GASTON

<i>Cherryville</i>	J. Kine	Bessemer City
	L. H. J. Houser	Cherryville
<i>Crowders Mtn.</i>	John J. Ormand	Bessemer City
<i>Dallas</i>	D. A. Medlin	High Shoals
	J. A. Furday	Dallas
<i>Gastonia</i>	L. E. Rankin	Gastonia
<i>River Bend</i>	W. B. Rutledge	Mount Holly
<i>South Point</i>		

GRANVILLE

<i>Brassfield</i>		
<i>Dutchville</i>		
<i>Fishing Creek</i>	E. C. Harris	
<i>Oak Hill</i>	J. S. Watkins	Virgilina, Va, R. 2
<i>Oxford</i>	C. H. Cheatham	Oxford
	B. Z. Royster	Oxford
<i>Sassafras Fork</i>	C. C. Heggie	Stovall
<i>Salem</i>		
<i>Tally Ho</i>	E. N. Clement	Oxford, R. 1
	W. S. Gooch	Stem
<i>Walnut Grove</i>	B. T. Dean	Oxford, R. 4

GUILFORD

<i>Bruce</i>	J. B. Ogburn	Summerfield
	C. H. Willson	Summerfield
<i>Center Grove</i>	L. A. Walker	Summerfield
	W. D. Clayton	Summerfield
<i>Clay</i>		
<i>Deep River</i>		
<i>Fentress</i>	J. M. Watlington	Pleasant Garden
<i>Friendship</i>		
<i>Gilmer</i>		
<i>Greene</i>	L. W. Causey	Liberty
	W. M. Hanner	Liberty

GUILFORD—Continued

<i>High Point</i>	G. B. Yarbrough	102 Ennis Street, High Point
<i>Jamestown</i>	E. S. Armfield	Greensboro, R. 3
<i>Jefferson</i>	H. L. Cannon	Pleasant Garden
	E. S. Holt	McLeansville
<i>Madison</i>		
<i>Monroe</i>		
<i>Morehead</i>		
<i>Oak Ridge</i>	D. L. Donnell	Oak Ridge
<i>Rock Creek</i>	W. R. Wood	Gibsonville
<i>Summer</i>	A. O. Newman	Greensboro, R. 1
	R. C. Short	Greensboro, R. 1
<i>Washington</i>	W. T. Cummings	Gibsonville

IREDELL

<i>Barringer</i>		
<i>Bethany</i>		
<i>Chambersburg</i>	J. T. Carter	
<i>Coddle Creek</i>		
<i>Concord</i>		
<i>Cool Spring</i>	V. C. Montgomery	Statesville, R. 7
	H. L. Swann	Statesville, R. 4
<i>Davidson</i>		
<i>Eagle Mills</i>	P. B. Kennedy	Houstonville
	A. F. Cook	Harmony, R. 3
<i>Fallstown</i>	J. H. Troutman	Troutmans
<i>New Hope</i>	D. A. Warren	New Hope
	J. L. Reid	New Hope
<i>Olin</i>		
<i>Sharpsburg</i>	W. B. McLelland	Stony Point, R. 2
<i>Shiloh</i>		
<i>Statesville</i>		
<i>Turnersburg</i>		
<i>Union Grove</i>	J. W. Crater	Olin

LEE

<i>Cape Fear</i>		
<i>Deep River</i>		
<i>East Sanford</i>		
<i>Greenwood</i>	J. J. Edwards	Lemon Springs
<i>Jonesboro</i>		
<i>Pocket</i>	J. H. Henley	Sanford
	D. A. Cole	Sanford, R. 1
	John B. Cameron	Sanford, R. 3
	W. E. Paschal	Sanford, R. 3
<i>West Sanford</i>	W. S. Weatherspoon	Sanford
	J. F. Jones	Broadway

LINCOLN

<i>Catawba Springs</i>	D. C. K. Wilkinson	Iron Station
<i>Howards Creek</i>	T. A. Warlick	Reepsville
	R. B. Sullivan	Hickory
	Charles Black	Crouse
	W. C. Kiser	Reepsville
<i>Ironton</i>	J. E. Reinhardt	Iron Station
	G. B. Goodson	Lincolnton
<i>Lincolnton</i>	T. J. Ramsaur	
<i>North Brook</i>	T. Pate Jenks	Henry
	C. W. Beam	Cherryville

MECKLENBURG

<i>Berryhill</i>	R. C. Freeman	Charlotte, R. 4
<i>Charlotte</i>	J. A. Baldwin	Charlotte
	J. Y. Orders	Charlotte, R. 2
<i>Clear Creek</i>	C. P. Munge	Allen, R. 1
<i>Crab Orchard</i>	W. M. Junker	Allen
<i>Deweese</i>	J. L. Sloan	Davidson

MECKLENBURG—Continued

<i>Deweese</i>	W. P. Sloan	Davidson
<i>Huntersville</i>	M. W. Van Pelt	Huntersville
	J. L. Mayberry	Huntersville
<i>Lemleys</i>	M. M. Blythe	Huntersville, R. 22
<i>Long Creek</i>	W. P. Craven	Charlotte, R. 6
	W. M. Kearns	Huntersville, R.F.D.
<i>Mallard Creek</i>	H. Y. Galloway	Derita, R. 14
<i>Morning Star</i>		
<i>Paw Creek</i>		
<i>Pineville</i>	W. M. Garrison	Pineville
<i>Providence</i>		
<i>Sharon</i>	W. T. Pharr	Charlotte
	A. B. Hood	Matthews, R. 17
<i>Steele Creek</i>	C. R. Choate	Charlotte, R. 3
	John L. Millwee	Pineville, R. 15

MOORE

<i>Ben Salem</i>	E. K. Sheffield	Eagle Springs
	J. M. Deaton	Spies, R. 2
	McI. Kennedy	Eagle Springs
<i>Carthage</i>	J. S. Currie	Carthage
<i>Deep River</i>		
<i>Greenwood</i>	H. P. McPherson	Cameron
	M. D. McLean	Cameron
<i>McNeills</i>	D. C. Lemon	Southern Pines
<i>Mineral Springs</i>		
<i>Ritters</i>	J. T. Seawell	Putnam
<i>Sand Hills</i>	Bion H. Butler	Southern Pines
<i>Sheffields</i>	D. H. Homer	Henry
	W. G. Carter	Carters Mills

MONTGOMERY

<i>Biscoe</i>	Sam T. Ewing	Candor
	Carl McGill	Steeds
	N. C. McLeod	Biscoe
	J. M. Wright	Biscoe
<i>Cheeks Creek</i>	J. R. McKenzie	Pekin
	D. J. Poole*	Pekin
<i>Eldorado</i>	N. M. Thayer	Eldorado
	J. A. Kirk	Eldorado
<i>Little River</i>	W. A. Leach	Martins Mill
<i>Mount Gilead</i>	John A. McAulay	Mount Gilead
<i>Ophir</i>	N. S. Hamilton	Immer
<i>Pee Dee</i>		
<i>Rocky Springs</i>	J. F. Whitlock	Sulphur Springs
	M. A. Bennett	Jackson Springs
<i>Troy</i>	J. R. Wallace	Troy
	L. R. Lisk	Troy
	O. B. Deaton	Troy
	Barna Allen	Troy
<i>Uwharrie</i>		
<i>Wadeville</i>	J. B. Henley	Wadeville

ORANGE

<i>Bingham</i>	T. J. Oldahm	Mebane, R. 2
<i>Cedar Grove</i>		
<i>Chapel Hill</i>	J. M. Loyd	Hillsboro
	M. Lindsay	Chapel Hill
<i>Cheeks</i>	James O. Webb	Efland
<i>Eno</i>	Robert M. Hill	Hillsboro
<i>Hillsboro</i>		
<i>Little River</i>		

PERSON

<i>Allenville</i>	W. T. Whitt	Roxboro, R. 2
<i>Bushy Fork</i>	A. M. Long	Hurdle Mills
	R. S. Bayner	Hurdle Mills, R. 2
<i>Cunningham</i>		

PERSON—Continued

<i>Flat River</i>	J. C. Cates	Timberlake
<i>Holloway</i>	G. E. Woody	Woodsdale
	J. B. Barrett	Woodsdale, R. 2
	S. P. Gentry	Denniston, Va., R. 1
<i>Mount Tirzah</i>		
<i>Olive Hill</i>	T. C. Wagstaff	Roxboro
	W. A. Winstead	Roxboro, R. 3
<i>Roxboro</i>	J. W. Younger	Roxboro
<i>Woodsdale</i>		

RANDOLPH

<i>Asheboro</i>	J. S. Ridge	Asheboro
<i>Back Creek</i>	N. H. Ferguson	Randleman
<i>Brower</i>	M. F. Wrenn	Steeds, R. 1
<i>Cedar Grove</i>		
<i>Coleridge</i>	H. T. Bray	Ramseur, R. 1
	H. P. Moffitt	Ramseur
	Robt. L. Caviness	Coleridge
<i>Columbia</i>	John T. Turner	Ramseur
<i>Concord</i>	J. M. Yates	Caraway
<i>Franklinville</i>	J. V. Free	Cedar Falls
<i>Grant</i>	C. O. Ingold	Asheboro, R. 1
	S. S. Cox	Asheboro, R. F. D.
<i>Level Cross</i>		
<i>Liberty</i>	W. B. Owen	Liberty
	R. C. Palmer	Liberty
<i>New Hope</i>		
<i>New Market</i>	J. A. Wall	Sophia
<i>Pleasant Grove</i>	J. A. Ward	Cheeks
<i>Providence</i>		
<i>Randleman</i>	N. T. Groce	Worthville
	O. C. Marsh	Randleman
<i>Richland</i>	A. C. Lowdermilk	Seagrove
	C. E. Stuart	Seagrove
<i>Tabernacle</i>	W. H. Lawrence	Caraway, R. 1
<i>Trinity</i>		
<i>Union</i>	S. A. Cox	Pisgah
	W. A. Presnell	Seagrove

ROCKINGHAM

<i>Huntsville</i>		
<i>Leaksville</i>	J. M. Price	Leaksville
	L. J. Shelton	Spray
<i>Madison</i>		
<i>Mayo</i>	T. L. Smith	Stoneville
<i>New Bethel</i>	W. G. Sharpe	Wentworth, R. 1
<i>Price</i>		
<i>Reidsville</i>	T. J. Martin	Pelham
<i>Ruffin</i>	W. K. Gibbs	Reidsville
<i>Simpsonville</i>	D. E. Purcell	Wentworth
	James W. Moore	Reidsville, R. 3
<i>Wentworth</i>	A. J. Whittemore	
	George T. Davis	Reidsville
<i>Williamsburg</i>		

ROWAN

<i>Atwell</i>	J. L. Fleming	China Grove, R. 2
	A. L. Deal	Mooresville
	F. D. Patterson	China Grove
<i>China Grove</i>		
<i>Cleveland</i>	W. C. Goodman	Cleveland
	A. Leroy Powlas	Barber
	D. B. Rosebrough	Cleveland
	E. B. Davis	Cleveland
	J. Cicero Miller	Salisbury, R. 1
<i>Franklin</i>	J. A. Earnhardt	Gold Hill
<i>Gold Hill</i>	G. H. Peeler	Rockwell

ROWAN—Continued

<i>Lock</i>		
<i>Litaker</i>		
<i>Morgan</i>	G. M. Hoffman	Gold Hill
	C. A. Campbell	Gold Hill
	M. Earnhardt	Gold Hill
	John W. Miller	Richfield, R. 2
	G. Allen Trexler	Gold Hill
	Paul T. Goodman	Gold Hill
<i>Mount Ulla</i>	J. C. Sherrill	Mount Ulla
	E. S. Miller	Mount Ulla
<i>Providence</i>	R. M. Peeler	Salisbury
<i>Salisbury</i>	A. L. Smoot	Salisbury
<i>Steel</i>	J. S. Hall	Barber
	C. T. Beeker	Mount Ulla
<i>Scotch-Irish</i>		
<i>Unity</i>		

STANLY

<i>Almond</i>	U. S. Burleyson	Albemarle, R. 6
	R. H. Burleyson	Albemarle
<i>Big Lick</i>		
<i>Center</i>		
<i>Endy</i>	L. H. Bost	Albemarle, R. 6
<i>Furr</i>	A. F. Haigler	Stanfield
	J. H. McClure	Mount Pleasant
<i>Harris</i>	D. R. Parker	Palmerville
	E. C. Bost	New London
	E. A. Ridenhour	Richfield
<i>North Albemarle</i>		
<i>Ridenhour</i>	R. L. Lipe	Richfield, R. 1
<i>South Albemarle</i>	J. J. Efrid	
	J. C. Parker	Albemarle
<i>Tyson</i>	J. M. Reap	Albemarle, R. 5

STOKES

<i>Beaver Island</i>	J. Wilson Mitchell	Dillard
<i>Big Creek</i>	Joe Francis	Francisco
	J. R. Forrest	Francisco
<i>Danbury</i>		
<i>Meadows</i>	Samuel C. Hill	Germanton
	I. G. Ross	Walnut Cove
<i>Peters Creek</i>		
<i>Quaker Gap</i>	J. R. East	
<i>Sauratown</i>		
<i>Snow Creek</i>		
<i>Yadkin</i>	D. V. Carroll	Mizpah

UNION

<i>Buford</i>	R. W. Elliott	Monroe
<i>Goose Creek</i>	A. W. McManus	Unionville, R. 1
<i>Jackson</i>	W. R. McNeely	Waxhaw
	Wm. McWhorter	Waxhaw, R. 5
<i>Lanes Creek</i>	B. F. Parker	Monroe
<i>Marshville</i>	T. C. Griffin	Marshville
	F. W. Ashcraft	Marshville
<i>Monroe</i>		
<i>New Salem</i>		
<i>Sandy Ridge</i>	J. N. Price	Monroe, R. 5
<i>Vance</i>		

VANCE

<i>Dabney</i>	J. T. Alderman	Henderson
<i>Henderson</i>		

VANCE—Continued

<i>Kittrell</i>	J. B. Allen	Henderson, R. 4
<i>Middleburg</i>	T. B. Porham	Henderson, R. 3
<i>Nutbush</i>	C. M. White	Manson
<i>Sandy Creek</i>	E. T. Alston	Henderson, R. 1
<i>Townsville</i>	J. E. Kimball	
<i>Watkins</i>	H. D. Floyd	Henderson, R. 5
<i>Williamsboro</i>	J. H. Rice	Henderson, R. 7
	R. A. Bullock	Henderson, R. 3

WAKE

<i>Bartons Creek</i>		
<i>Buckhorn</i>	A. C. Olive	New Hill
<i>Cary</i>		
<i>Cedar Fork</i>		
<i>Holly Springs</i>		
<i>House Creek</i>		
<i>Leesville</i>		
<i>Little River</i>		
<i>Marks Creek</i>		
<i>Middle Creek</i>		
<i>Neuse River</i>	J. D. Willson	Neuse
	J. B. Wiggins	Neuse, R. 1
<i>New Light</i>		
<i>Panthers Branch</i>	Miss S. M. Adams	Willow Springs
<i>Raleigh</i>	Arch J. Woods	
<i>St. Marys</i>		
<i>St. Matthews</i>		
<i>Swift Creek</i>	T. A. Whitaker	Raleigh
<i>Wake Forest</i>		
<i>White Oak</i>	Sexton Lawrence	Apex, R. 3

WARREN

<i>Fishing Creek</i>	J. F. Hunter	Arcola
	O. C. Davis	Grove Hill
<i>Fork</i>	W. H. Pridgen	Creek
<i>Hawtree</i>	J. D. Newell	Macon
<i>Judkins</i>		
<i>Nutbush</i>	R. D. Paschall	Ridgeway
<i>River</i>	A. L. Pope	Vaughn
<i>Roanoke</i>	H. L. Wall	Elams
<i>Sandy Creek</i>	S. J. Pritchard	Henderson, R. 6
<i>Shocco</i>	J. B. Davis	Alston
<i>Six-pound</i>		
<i>Smith Creek</i>	J. F. P. Harton	Norlina
	W. C. Mabry	Ridgeway
	G. E. White	Norlina

Warrenton

YADKIN

<i>Boonville</i>	A. S. Speer	Boonville
<i>Buck Shoal</i>	E. G. Myers	Buck Shoal
	G. T. White	Buck Shoal
<i>Deep Creek</i>	J. W. McCoy	Yadkinville
<i>East Bend</i>	W. Y. Wall	East Bend
<i>Fall Creek</i>	E. B. Vestal	Siloam
	J. R. Hall	Siloam
	E. J. Vestal	Yadkinville
<i>Forbush</i>	J. K. Gough	East Bend
	John H. Eaton	Yadkinville, R. 2
<i>Knobs</i>		
<i>Liberty</i>	J. L. Crater	Yadkinville
<i>Little Yadkin</i>	Will A. Jones	Lewisville, R. 1

COASTAL PLAIN REGION

BEAUFORT

<i>Bath</i>	G. H. Elliott	Washington
	W. M. Kear	Washington
<i>Chocowinity</i>		
<i>Long Acre</i>		
<i>Pantego</i>		
<i>Richland</i>	J. A. Hardy	Aurora
	H. E. Tripp, Jr.	Blounts Creek
<i>Washington</i>		

BERTIE

<i>Colerain</i>		
<i>Indian Woods</i>	E. D. Spruill	Quitsna
<i>Merry Hill</i>	T. A. Smithwick	Merry Hill
<i>Mitchells</i>	H. L. Early	Aulander
<i>Roxobel</i>	W. R. Brown	Kelford
	T. S. Norfleet	Roxobel
	Geo. T. Parker	Kelford
<i>Snakebite</i>	J. Rufus Cherry	Windsor
<i>Whites</i>	J. H. Lawrence	Colerain, R. 3
	H. J. Ward	
<i>Windsor</i>	W. D. White	Windsor, R. 3
<i>Woodville</i>		

BLADEN

<i>Abbotts</i>		
<i>Bethel</i>	A. R. Edwards	Bladenboro
<i>Bladenboro</i>	S. N. Ferguson	Bladenboro
<i>Brown Marsh</i>	E. J. Cox	Clarkton
<i>Carvers Creek</i>	S. M. Newell	Council
	F. F. Dickson	Council
<i>Central</i>	R. P. Tatum	Ruskin
<i>Colly</i>	D. A. Nanbler	Elizabethtown
	J. L. Peterson	Elizabethtown
<i>Cypress Creek</i>		
<i>Elizabethtown</i>	R. B. Cromartie	Elizabethtown
	A. H. Pait	Elizabethtown
<i>Frenchs Creek</i>		
<i>Hollow</i>	S. F. Cain	Tar Heel
<i>Lake Creek</i>	D. J. Sessoms	Ivanhoe, R. 2
<i>Turnbull</i>		
<i>White Oak</i>		
<i>White's Creek</i>	I. A. Register	Clarkton

BRUNSWICK

<i>Northwest</i>		
<i>Lockwoods Folly</i>		
<i>Shallotte</i>	Troy Hewett	Shallotte
<i>Smithville</i>		
<i>Town Creek</i>	J. B. Atkinson	Winnabow
<i>Waccamaw</i>	R. C. Phelps	Ash

CAMDEN

<i>Court House</i>	T. B. Godfrey	Camden
	Mrs. B. Sawyer	Belcross
<i>Shiloh</i>	M. S. Jones	Old Trap
<i>South Mills</i>		

CARTERET

<i>Beaufort</i>		
<i>Cedar Island</i>	J. B. Goodwin	Roe
	T. L. Goodwin	Roe
<i>Hunting Quarters</i>		
<i>Merrimon</i>		

CARTERET—Continued

Morehead
Newport
Portsmouth
Straits
White Oak
Smyrna

CHOWAN

<i>No. 1</i>		
<i>No. 2</i>	M. B. Chappel	Edenton
<i>No. 3</i>	E. W. Welch	Tyner
<i>No. 4</i>		

COLUMBUS

<i>Bogue</i>		
<i>Bolton</i>	M. D. Creech	Bolton
	John Innes	Bolton
<i>Bug Hill</i>	G. L. Holmes	Dotham
	J. H. Lay	Pireway
<i>Chadbourn</i>		
<i>Fair Bluff</i>		
<i>Lees</i>	James A. Pierce	Vineland
	N. M. Ward	Nakina
<i>Ransom</i>	W. L. Hobbs	New Berlin
<i>South Whiteville</i>	B. White	Vineland
<i>South Williams</i>		
<i>Tatums</i>	D. F. McLelland	Evergreen
	A. H. Porter	Whiteville
<i>Waccamaw</i>	K. B. Council	Wananish
<i>Welches Creek</i>	J. M. Smith	Whiteville
<i>Whiteville</i>	D. H. Collier	Whiteville
<i>Williams</i>	W. C. Gore	Clarendon

CRAVEN

<i>No. 1</i>		
<i>No. 2</i>		
<i>No. 3</i>		
<i>No. 4</i>		
<i>No. 5</i>	John S. Morton	North Harlowe
	James L. Taylor	Bachelor
<i>No. 6</i>	E. A. Armstrong	Havelock
	T. E. Haywood	Croatan
	John L. Tull	Havelock
<i>No. 7</i>		
<i>No. 8</i>		
<i>No. 9</i>		

CUMBERLAND

<i>Beaver Dam</i>	F. E. Bullard	Roseboro
<i>Black River</i>	N. Williams	Godwin
<i>Carvers Creek</i>	J. E. Jordan	Overhills (Harnett County)
<i>Cedar Creek</i>		
<i>Cross Creek</i>		
<i>Flea Hill</i>	D. D. Bain	Wade, R. 1
	H. H. Bolton	Fayetteville, R. 1
<i>Grays Creek</i>		
<i>Manchester</i>		
<i>Pearces Mill</i>	G. M. Powell	Humboldt, Tenn.
	C. C. Howard	Fayetteville
<i>Rockfish</i>		
<i>Seventy-first</i>		

CURRITUCK

<i>Atlantic</i>	Mrs. N. T. Hurdle	
	W. J. Tate	Coinjock
<i>Crawford</i>	A. B. Midgett	Coinjock
	E. R. Johnson	Currituck
<i>Fruitville</i>	W. T. Fentress	Knotts Island
	David Jones	Knotts Island
<i>Moyock</i>	W. M. Stewart	Vine, Va.
<i>Poplar Branch</i>	W. N. Hampton	Poplar Branch
	R. L. Newbern	Olds

DARE

<i>Croatan</i>	C. R. Fulcher	Manns Harbor
	G. W. Hooper	Stumpy Point
<i>East Lake</i>		
<i>Hatteras</i>	N. F. Jennett	Buxton
	B. B. Ballance	Hatteras
<i>Kennekeet</i>		
<i>Nags Head</i>	M. G. Hollowell	Nags Head

DUPLIN

<i>Albertson</i>	W. G. Kornegay	Alvin
<i>Cypress Creek</i>		
<i>Faison</i>	Z. V. Blount	Faison
<i>Glisson</i>		
<i>Island Creek</i>		
<i>Kenansville</i>	Henry Dail	Kenansville
<i>Limestone</i>		
<i>Magnolia</i>		
<i>Rock Fish</i>		
<i>Rose Hill</i>		
<i>Smith</i>		
<i>Warsaw</i>	W. R. Blackmore	Warsaw
<i>Wolfscrape</i>		

EDGECOMBE

<i>No. 1</i>		
<i>No. 2</i>		
<i>No. 3</i>	O. P. House	Speed
	V. B. Knight	Speed
<i>No. 4</i>		
<i>No. 5</i>	E. J. Hurdle	Tarboro
<i>No. 6</i>		
<i>No. 7</i>	S. N. Weeks	Battleboro
<i>No. 8</i>	B. T. Eagles	Macclesfield
<i>No. 9</i>	Wm. W. Eagles	Macclesfield
<i>No. 10</i>	Robert E. Pitt	Pinetops
	E. L. Pitt	Pinetops
<i>No. 11</i>	George D. Britt	Tarboro
<i>No. 12</i>	G. B. Cooper	
<i>No. 13</i>		
<i>No. 14</i>	H. L. Lancaster	Sharpsburg

GATES

<i>Gatesville</i>	John B. Walters	Gatesville
<i>Hall</i>		
<i>Hasletts</i>		
<i>Holly Grove</i>	W. C. Beaman	Savage
<i>Hunters Mill</i>	J. M. Beaman	Sunbury
<i>Mintonsville</i>		
<i>Rtynoldson</i>		

GREENE

<i>Bull Head</i>	C. C. Eason	Stantonsburg
<i>Carrs</i>		
<i>Hookerton</i>	W. A. Shackleford	Hookerton

GREENE—Continued

<i>Jason</i>	Levi Hill	Snow Hill
	W. D. Mewborn	LaGrange
<i>Olds</i>	T. E. Barrow	Farmville
<i>Ormonds</i>	W. A. Darden	Ayden
<i>Shine</i>		
<i>Speights Bridge</i>		
<i>Snow Hill</i>		

HALIFAX

<i>Brinkleyville</i>	N. M. Harrison	
	D. S. Moss	Ringwood
<i>Butterwood</i>	S. T. Thoone, Jr.	Airlie
<i>Conocoanara</i>	J. H. Darden	Springhill
<i>Enfield</i>		
<i>Faucetts</i>		
<i>Halifax</i>		
<i>Littleton</i>		
<i>Palmyra</i>	W. G. Hedgepeth	Hobgood
	W. H. White	Hobgood
<i>Roseneath</i>		
<i>Roanoke Rapids</i>		
<i>Scotland Neck</i>		
<i>Weldon</i>	J. W. Pierce	Weldon

HARNETT

<i>Andersons Creek</i>		
<i>Averasboro</i>	V. L. Stephens	Dunn
	J. W. Whitehead	Dunn
<i>Barbecue</i>	E. B. Hodgin	Spout Springs
<i>Black River</i>		
<i>Buckhorn</i>		
<i>Duke</i>	Wilson H. Lucas	Duke
<i>Grove</i>	T. D. Stewart	Coats
<i>Hectors Creek</i>		
<i>Johnsonville</i>		
<i>Lillington</i>	H. M. Spears	Lillington
	A. M. Show	Lillington
	Miss C. Withers	Lillington, R.
<i>Neills Creek</i>	F. H. Taylor	Buies Creek
<i>Stewarts Creek</i>	S. M. Hobbs	Linden
<i>Upper Little River</i>	J. B. F. Stewart	Mamers

HERTFORD

<i>Ahoskie</i>	A. E. Garrett	Ahoskie
<i>Harrellsville</i>	J. A. Powell	Harrellsville
<i>Mameys Neck</i>	S. P. Winborne	Como
<i>Murfreesboro</i>		
<i>St. Johns</i>	Clarence Chavis	Ahoskie
<i>Winton</i>	W. D. McGlohan	Enfield

HOKE

<i>Allendale</i>		
<i>Antioch</i>		
<i>Blue Springs</i>		
<i>Little River</i>	J. H. Priest	Marley
<i>McLaughlin</i>		
<i>Quewhifle</i>	N. A. McDonald	Timberland
<i>Raeferd</i>		
<i>Stonewall</i>		

HYDE

<i>Currituck</i>	L. A. Griffin	Scranton
	G. T. Radcliff	Leechville
<i>Fairfield</i>		
<i>Lake Landing</i>	J. M. Hall	Middletown
	John L. Mann	Lake Landing

HYDE—Continued

<i>Lake Landing</i>	George E. Roper	Engelhard
<i>Ocaracoke</i>		
<i>Swan Quarter</i>	J. W. Jarvis	Swan Quarter
	T. R. Credle	Swan Quarter

JOHNSTON

<i>Banner</i>	A. L. Stephenson	Benson
<i>Bentonville</i>	J. M. Beasley	Bentonville
	J. H. Langston	Bentonville
<i>Beulah</i>	W. G. Pittman	Kenly, R. 2
<i>Boon Hill</i>		
<i>Clayton</i>	W. D. Tomlinson	Clayton
<i>Cleveland</i>		
<i>Elevation</i>		
<i>Ingrams</i>	B. B. Adams	Four Oaks
<i>Meadow</i>	J. J. Rose	Bentonville, R. 2
<i>Micro</i>		
<i>O'Neals</i>		
<i>Pine Level</i>	H. R. Gerald	Pine Level
	W. F. Gerald	Pine Level
	N. G. Wigg	Princeton, R. 3
<i>Pleasant Grove</i>	C. H. Honeycutt	Angier, R. 1
<i>Selma</i>		
<i>Smithfield</i>	Wm. D. Avena	Smithfield, R. 1
<i>Wilders</i>	Bruce Barnes	Clayton
	J. I. Whittey	Wendell, R. 1
<i>Wilsons Mills</i>	C. M. Wilson	Wilsons Mills

JONES

<i>Beaver Creek</i>		
<i>Chinquapin</i>		
<i>Cypress Creek</i>	C. S. Rhodes	Comfort
<i>Pollocksville</i>	F. H. Foy	Pollocksville
<i>Trenton</i>	T. A. Windley	Trenton
<i>Tuckahoe</i>		
<i>White Oak</i>		

LENOIR

<i>Contentnea Neck</i>	J. S. Abbott	Kinston, R. 1
<i>Falling Creek</i>	G. F. Parrott	Kinston, R. 3
<i>Institute</i>		
<i>Kinston</i>		
<i>Moseley Hall</i>		
<i>Neuse</i>		
<i>Pink Hill</i>	R. K. Noble	Deep River
<i>Sand Hill</i>	F. Leo West	Kinston, R. 6
<i>Southwest</i>	G. F. Loftin	Kinston
<i>Trent</i>		
<i>Vance</i>	E. C. Carraway	Kinston, R. 2
<i>Woodington</i>	E. H. Waller	Kinston, R. 5

MARTIN

<i>Bear Grass</i>	W. A. Perry	Williamston, R. 1
	McG. Taylor	Williamston
<i>Cross Roads</i>		
<i>Goose Nest</i>		
<i>Griffins</i>	C. C. Collrain	Jonesville
<i>Hamilton</i>		
<i>Jamesville</i>		
<i>Poplar Point</i>	Jesse A. Leggett	Williamston, R. 3
<i>Robersonville</i>	A. L. Bellflower	Parmele
<i>Williams</i>		
<i>Williamston</i>	J. L. Collrain	Williamston
	J. G. Staton	Williamston

NASH

<i>Bailey</i>	J. F. Findo	Middlesex
<i>Castalia</i>	J. M. Braswell	Castalia

NASH—Continued

<i>Coopers</i>		
<i>Dry Wells</i>	J. H. Smith	Middlesex
<i>Ferralls</i>	W. B. Bergeron	Middlesex
<i>Griffins</i>	A. W. Cooper	Whitakers
<i>Jacksons</i>		
<i>Mannings</i>	J. S. Sykes	Spring Hope
<i>Nashville</i>	Wm. B. Boddie	Nashville
<i>North Whitakers</i>		
<i>Oak Level</i>	W. H. Proctor	Nashville
<i>Red Oak</i>	J. A. Beal	Battleboro
<i>Rocky Mount</i>	J. W. Robbins	Sharpsburg
<i>South Whitakers</i>		
<i>Stony Creek</i>	J. W. Culpepper	Rocky Mount
	J. C. Harper & Co.	Nashville

NEW HANOVER

<i>Cape Fear</i>	Henry Horne	Wilmington
	N. H. McGirt	Wilmington
	John R. Morris	Wilmington, R. 1
<i>Federal Point</i>		
<i>Harnett</i>		
<i>Masonboro</i>		
<i>Wilmington</i>		

NORTHAMPTON

<i>Gaston</i>	E. M. Clements	Stancell
<i>Jackson</i>	G. A. Moore	Jackson
<i>Kirby</i>		
<i>Oconeechee</i>		
<i>Pleasant Hill</i>		
<i>Rich Square</i>	A. J. Conner	Rich Square
	Albert Vann	Rich Square
<i>Roanoke</i>	J. J. Parker	Lasker
<i>Seaboard</i>		
<i>Wicaccanee</i>		

ONSLow

<i>Jacksonville</i>		
<i>Richlands</i>	J. W. Fountain	Richlands
	F. D. Shaw	Richlands
<i>Stump Sound</i>	J. T. Shepard	Hollyridge
<i>Swanboro</i>	T. H. Prichard	Swanboro
<i>White Oak</i>	J. E. Freeman	

PAMLICO

<i>No. 1</i>		
<i>No. 2</i>	B. D. Eubank	Stonewall
	J. W. Martin	
<i>No. 3</i>	E. E. Mayo	Mesic
<i>No. 4</i>	J. R. Sadler	Lowland
<i>No. 5</i>		

PASQUOTANK

<i>Elizabeth City</i>	T. B. Wilson	Elizabeth City
<i>Mount Hermon</i>		
<i>Newland</i>	W. J. Albertson	Elizabeth City, R. 4
	W. J. Williams	Elizabeth City, R. 6
<i>Nixonton</i>	J. L. Brock	
<i>Providence</i>	M. P. Jennings	Elizabeth City, R. 3
<i>Salem</i>	J. C. James, Jr.	Weeksville

PENDER

<i>Burgaw</i>	A. H. Paddison	Burgaw
<i>Caintuck</i>	D. J. Corbett	Currie
	F. P. Flynn	Currie
	B. F. Keith	Currie
<i>Caswell</i>	E. A. Hawes, Sr.	Atkinson

PENDER—Continued

<i>Columbia</i>		
<i>Grady</i>		
<i>Holly</i>		
<i>Long Creek</i>	J. E. Henry	Rocky Pt., R. F. D.
<i>Rocky Point</i>	W. W. Pearsall	Rocky Point
<i>Topsail</i>	The Pine Lbr. Co.	New Bern
<i>Union</i>	N. W. Powers	Willard

PERQUIMANS

<i>Belvidere</i>	H. P. White	Belvidere
<i>Bethel</i>		
<i>Hertford</i>		
<i>New Hope</i>	Arthur Butt	Hertford, R. 3
<i>Parkville</i>		

PITT

<i>Ayden</i>	J. R. Smith & Bro.	Ayden
	Rev. T.E. Beaman	Ayden
<i>Beaver Dam</i>	J. J. Harrington	Greenville
<i>Belvoir</i>		
<i>Bethel</i>	M. O. Blount	Bethel
	S. T. Carson	Bethel
	R. D. Whitehurst	Bethel
	Eureka Lbr. Co.	Washington
<i>Carolina</i>		
<i>Chicod</i>	W. L. Clarke	Chicod
<i>Falkland</i>	Abner Eason	Fountain
<i>Farmville</i>	John T. Thorne	Farmville
<i>Greenville</i>	D. H. Joyner	Greenville
<i>Pactolus</i>	J. E. Clark, Jr.	Washington
<i>Swift Creek</i>	M. R. Quinerly	Grifton
<i>Winterville</i>	J. J. May	Greenville

RICHMOND

<i>Beaver Dam</i>	C. H. Teague	Hoffman
	C. M. Thompson	Hoffman
<i>Black Jack</i>	J. F. Capel	Ellerbe
<i>Marks Creek</i>	W. H. H. Bagwell	Hamlet
	M. B. Nicholson	Osborne
<i>Mineral Springs</i>	J. R. Bennett	Ellerbe
	J. A. Covington	Ellerbe, R. F. D.
<i>Rockingham</i>	J. A. Hutchison	Roberdell
<i>Steeles</i>	A. J. Little	Mangum
<i>Wolf Pit</i>	W. H. Roberts	Rockingham, R. 1

ROBESON

<i>Alfordsville</i>		
<i>Back Swamp</i>		
<i>Britts</i>		
<i>Burnt Swamp</i>		
<i>Fairmont</i>	J. P. Brown	Fairmont
<i>Gaddy</i>		
<i>Howellsville</i>	D. C. Regan	Lumberton, R. 7
<i>Lumber Bridge</i>	H. M. John	Lumber Bridge
<i>Lumberton</i>		
<i>Maxton</i>	Rosy McNair	Maxton
<i>Orrum</i>	M. W. Hedgpeth	Orrum
	I. H. Warwick	Orrum
<i>Parkton</i>		
<i>Pembroke</i>		
<i>Raft Swamp</i>	J. E. Carlyle	Buies
	R. H. Gregory	Lumberton, R. 6
	W. C. Townsend	Buies
<i>Red Springs</i>	A. D. McLeod	Red Springs
	J. L. McMillan	Red Springs
<i>Rennert</i>	C. W. Watson	Rennert

ROBESON—Continued

<i>Rowland</i>	A. T. McKeller	Rowland
<i>Saddle Tree</i>		
<i>St. Pauls</i>	Joseph Allen	St. Pauls
	Marcus Smith	St. Pauls
<i>Shannon</i>		
<i>Smiths</i>		
<i>Sterlings</i>		
<i>Thompson</i>	Foster Williams	McDonald
<i>White House</i>		
<i>Wishart</i>	J. Troy Phillips	Lumberton

SAMPSON

<i>North Clinton</i>	J. A. McArthur	Clinton
<i>South Clinton</i>		
<i>Dismal</i>	J. S. Horne	Autryville
	W. B. Page	Cooper
<i>Franklin</i>		
<i>Halls</i>	John A. Fort	Clinton
<i>Herrings</i>		
<i>Honeycuts</i>		
<i>Lisbon</i>	C. A. Brown & Bro.	Garland
<i>Little Coharie</i>		
<i>McDaniels</i>		
<i>Mingo</i>		
<i>Newton Grove</i>	W. A. Bizzell	Newton Grove
	I. W. Westbrook	Mt. Olive, R. 7
<i>Piney Grove</i>		
<i>Taylors Bridge</i>	A. R. Herring	Delway
<i>Turkey</i>	L. D. Rogers	Turkey
<i>Westbrooks</i>	Westbrook Lee, Sr.	Newton Grove

SCOTLAND

<i>Laurel Hill</i>		
<i>Spring Hill</i>		
<i>Stewartsville</i>		
<i>Williamson</i>	J. A. McNeill	Laurel Hill

TYRRELL

<i>Alligator</i>	A. Melson	Fort Landing
<i>Columbia</i>	E. B. Hopkins	Columbia
	W. E. Spencer	Columbia
<i>Gum Neck</i>		
<i>Scuppernong</i>	E. R. Davenport	Columbia, R. 1
<i>South Fork</i>		

WASHINGTON

<i>Lees Mills</i>	J. E. Singleton	Roper
	N. C. Vail	Plymouth
<i>Plymouth</i>	D. G. Darden	Plymouth
	W. J. Jackson	Plymouth
<i>Scuppernong</i>	W. T. Phelps	Creswell
	J. F. Snell	Creswell
<i>Skinner'sville</i>		

WAYNE

<i>Brogden</i>	John A. Toler	Goldsboro
	Basil J. Bowden	Dudley
	W. F. English	Mount Olive
<i>Buck Swamp</i>	B. F. Smith	Pikeville
<i>Fork</i>	W. C. Hollowell	Goldsboro
	D. C. Pipkin	Goldsboro
	W. G. Hollowell	Goldsboro, R. 6
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<i>Graham</i>		
<i>Great Swamp</i>	B. R. Egerton	Kenly, R. 1
<i>Indian Springs</i>		
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Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

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Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest-fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albermarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. Postage 25 cents.

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